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# MARINE ENGINEERING.

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## H. M. S. FAME A RECENT TYPE OF BRITISH TORPEDO-BOAT DESTROYER.

An up-to-date British torpedo boat destroyer, H. M. S. Fame, is shown in the engraving reproduced from a photograph taken during her trial trip. The mean of her three-hours run was 30.168 knots, with 5,850 I. H. P. This boat is one of a group of eight built for the Admiralty by John I. Thornycroft & Co., of Chiswick, London. On trial these boats proved to be extremely handy and fast. Although going at a high rate of speed, it will be noticed that the trim of the boat is not much altered, nor does she kick up much of a fuss in the water. The general dimensions are: Length, 208 ft. on the water line, 210 ft. over all; maximum breadth, 19 ft. 6 in.; depth, 13 ft. 6 in. The load draft is about 5 ft. 10 in. forward, 7 ft. aft and the displacement about 272 tons. The weight of the propelling machinery is nearly 128 tons. The engines are of the Thornycroft type, triple-expansion, with piston valves and cylinders 20 in., 29 in. and two 30 in. dia., and 18 in. stroke. At full speed they make slightly less than 400 turns. There are three boilers of the Thornycroft type, with 66 ft. grate surface and 4,000 ft. heating surface, worked at a pressure of 205 pounds

H. M. TORPEDO-BOAT DESTROYER FAME DOING 30.168 KNOTS WITH 5,850 I. H. P.

per sq. in. At top speed the coal consumption is 2.43 pounds and at low speed 1.67 pounds.

In the construction of this group of boats light scantlings of high grade steel were used to secure lightness. This material had a tensile strength of about 40 tons to the square inch and an elongation of 15 per cent in 10 in. The increased strength and stiffness was secured by the use of a new alloy. A feature of the design is the form of bow, which slopes forward from the water line, and, as the sides are flared very much forward, the boat is comparatively dry even when steaming fast to the wind. The cutwater is also very fine. The boat is fitted with one 12 pounder R. F. gun and five 6 pounder R. F. guns, and two revolving torpedo tubes, for 18 in. Whitehead torpedoes. She has no bow discharge.

Just abaft the conning tower there is a navigating bridge, which permits of the working of the boat in the open, even in dirty weather. The stern is cut away in the usual Thornycroft style, the floor being arched, so that the propellers work in a "solid" body of water even in very rough water. As will be noticed, there are only two smoke pipes, the forward of which gives an outlet to two boilers, which are placed back to back. The after stack, which is outwardly the same size, serves, not only as a smoke pipe for the remaining boiler, but as a means of ventilating the engine room, the hot air passing up between the inner pipe and the outer casing.

The boats' complement is fifty-six. Some of the crew are berthed forward under the turtle back and others aft of the machinery space. The officers' quarters are right aft, in the traditional though not the most comfortable position.

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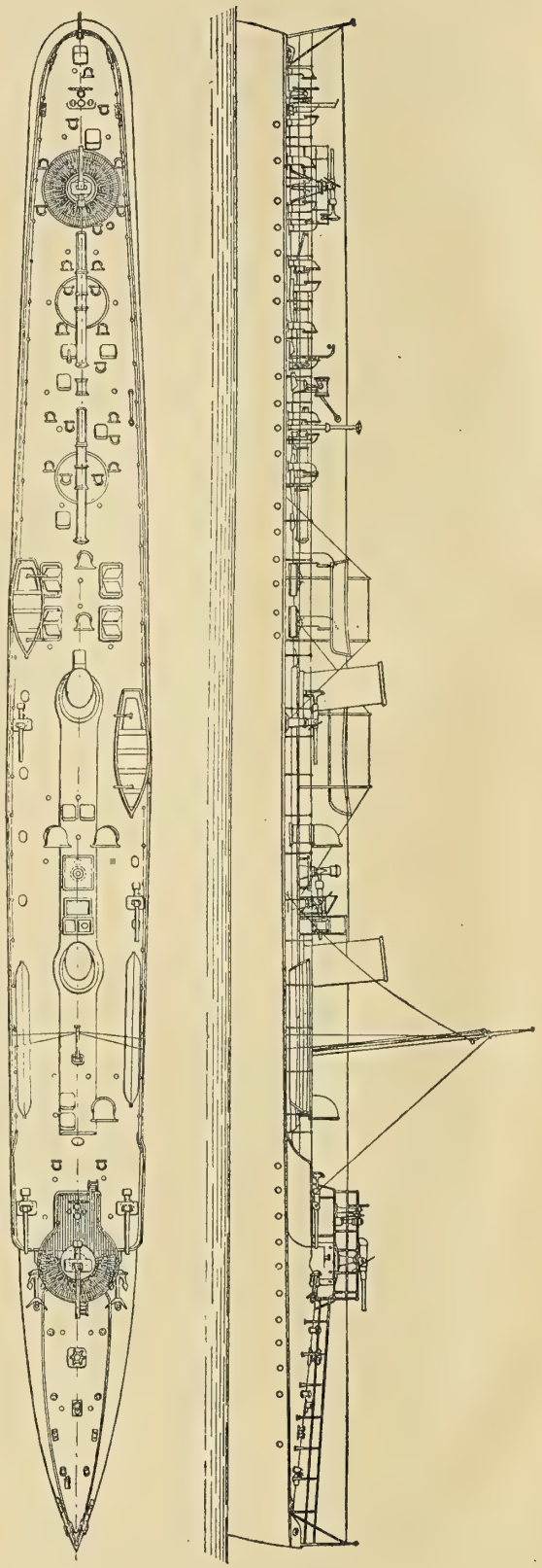
A new Castle liner for the English-South African mail service, to be built at the Fairfield Works on the Clyde, will have quadruple-expansion engines of 9,000 horse power, with a working pressure of 205 lbs. per sq. in.

A large floating dry dock capable of lifting a 15,000 ton vessel has been ordered by the Vulcan Shipbuilding and Engineering Co., of Stettin, from C. S. Swan & Hunter, of England. The first use which will be made of this dock will be the lengthening of the North German Lloyd liners Spree and Havel. These ships are about six years old. They are now 463 ft. long, 51 ft. 10 in. beam and 37 ft. deep. An additional 65 ft. will be built in amidships, bringing the length up to 528 ft. A more radical change, however, will be the substitution of two sets of engines driving twin screw for the single engines and screw of each vessel. The present engines are of the five-cylinder, three-crank triple-expansion type, indicating about 11,500 horse power. The new engines will be four-cylinder, four-crank triple-expansion, each vessel having about 18,000 horse power. Three new boilers will also be fitted in each vessel. An extra knot and a half is expected as a result of the alterations.



H.M.S. FAME, ONE OF A GROUP OF EIGHT THORNYCROFT TORPEDO-BOAT DESTROYERS BUILT FOR THE BRITISH NAVY.

## ON TORPEDO-BOAT DESIGN WITH SUGGESTIONS FOR HARBOR-DEFENSE AND SEA-GOING TYPES.*

BY ASST. NAVAL CONSTRUCTOR H. G. GILLMOR, U. S. N.

The torpedo as an offensive weapon made its appearance during the war of the rebellion from '60 to '65, and, by its achievements during that war, established itself as a factor to be considered in naval warfare. So many and so brilliant had been the successes which were achieved through its use in this war that it was almost immediately taken up by the maritime powers of Europe and became a recognized naval offensive weapon.

The torpedo of that time was the spar-torpedo; which, being carried at the end of a spar 20 to 25 ft. long., capable of being rigged out and in and placed at various angles, could be brought in contact with the bottom of the enemy's vessel by a pulling boat or a steam-launch and discharged by means of an electrical connection. For success it was necessary to come alongside the enemy before discovery and disablement. The rapid-fire gun of small caliber and the searchlight were not then in existence, so that the task of the torpedo in the hands of fearless men was, on a dark or foggy night, less impossible than might be thought.

For some years the torpedo remained as it was at the close of the war—the weapon of the regular pulling boats and steam launches of the man-of-war. Boats which in time of peace did duty as the regular running boats of the ship were provided with apparatus for the use of the spar-torpedo in time of war as a part of their equipment. Early in the seventies it was proposed to construct small special steam vessels, in which a lightness of hull, fineness of lines, and exceptionally large motive power would insure a speed of from 15 to 18 knots, for use as torpedo-boats. A little before this the Whitehead torpedo had been introduced and was being experimented with by all the European Powers. It was destined to revolutionize ideas of torpedo warfare and make more necessary the construction of the special torpedo vessels then proposed.

It is in England, in the yards of Messrs. Thornycroft and Yarrow, that special torpedo-boat construction was begun, and it is there that the torpedo-boat has become the very high-speed vessel that we possess to-day. The rivalry which has existed in the first instance between these two builders, and later among an increasing number of builders, has had quite as much to do with the development of the present types of torpedo-boats as have considerations of their warlike purpose and efficiency as means of offense. We are to-day accustomed to hear torpedo-boats spoken of as "20-knotters," or "30-knotters," as if speed, regardless of size, cost, number of men involved, offensive power, etc., were the one consideration in such vessels; and there is no doubt that in the popular mind a 30-knot boat must be far superior to a 20-knot or a 24-knot boat, no matter what may be the relations existing between other qualities of the two boats.

Messrs. Thornycroft built, in 1873, at their yards in Chiswick, to the order of the Norwegian government, the first special torpedo-boat constructed. This vessel, which was subsequently named the Wasp, was 57 ft. long, 7 ft. 6 in. beam, with a displacement of about 7 1-2 tons and a speed of about 15 knots. She was originally provided with an apparatus for the towing torpedo. France began, under the programme of January 30, 1875, the construction of torpedo-boats subject to the following limitations: Length, about 20 meters (75.6 ft.); hull of steel capable of resisting musket fire; maximum speed, 14 knots; sufficient coal for 8 hours at full speed. Our own government, in 1876, ordered a large wooden launch, the Lightning of the Herreshoff Manufacturing Co. She was 58 ft. long; was fitted with spar-torpedoes, and made about 17.5 knots on trial. In 1877, the Lightning, the first English torpedo-boat, was delivered by Messrs. Thornycroft to the English government. She was 85 ft. long and 11 ft. beam, with a displacement of 27 tons and made 19 knots on trial. The same year, the Russian government had no less than 100 boats of a similar character under construction at the Baltic works. These boats were 75 ft. long, 10 ft. beam, with a speed of 18 knots. Italy followed the next year with a vessel very much like the Lightning. About the same time the first German torpedo-boat was constructed. It was rather larger than the English and Italian boats. By the end of 1878 the torpedo-boat had a place in the navy lists of the European Powers.

About the time of the beginning of the construction of special torpedo-boats, the Whitehead torpedo had made such progress as to find some advocates for its use. From the uncertainties attending the action of the early automobile torpedo and the demonstrated efficiency of the spar-torpedo under the existing conditions, the latter was in many instances preferred to the former, and most of the early torpedo-boats were originally provided with spar-torpedoes and later fitted for the use of the automobile torpedoes. The introduction of the rapid-fire gun was the death-blow of the spar-torpedo and emphasized the necessity for high-speed torpedo vessels for use with the automobile torpedo. The torpedo itself, and the means for firing it, were rapidly improved. The growth and improvement in the torpedo-boat more than kept pace with its principal weapon.

From 1878 on, the work of construction of special torpedo vessels by the European Powers has gone on steadily, although, in the case of individual nations, there have been delays from indecision as to the types which should be taken up. An enlargement in the sphere of the tor-

*From a paper read before Society of Naval Architects and Marine Engineers, at the Fifth General Meeting.

pedo-boat, by which it was to prove its title to consideration as a separate branch of navies rather than one of the weapons of ships, was marked by the construction of sea-going torpedo-boats, of which the Batoum, completed in 1879 for Russia, was the first.

At the end of 1884, Russia possessed 115 torpedo-boats; France, 50; Holland, 22; England, 19; Italy, 18, and Austria, 17. At the end of the year 1890, France possessed 210 torpedo-boats; England, 206; Italy, 152; Russia, 143; Germany, 125; Japan, 24, and Spain, 15. The Cushing, the first United States torpedo-boat, was that year commissioned.

That we, the nation which of all nations had had the largest practical experience with torpedoes in actual warfare, should have been the last to take up the torpedo-boat—which, after all, was but the logical application of our own war experiences to altered conditions and improved weapons—was doubtless due, in the first instance, to the attitude of Congress toward the Navy, and its unwillingness to appropriate money for rebuilding and modernizing that important arm of the national defense, rather than to any lack of enterprise or foresight on the part of officers of the Navy. When public sentiment changed and Congress turned its attention to the needs of the Navy, demands for the larger modern ships seem to have been so urgent as to have kept the torpedo-boat out of notice, although, just at that time, large expenditures were being made by the European Powers for this class of vessel.

From the time of the construction of the torpedo-launch Lightning in 1876, nothing was done toward providing torpedo-boats for the Navy until 1888. That year the Navy Department purchased from the Herreshoff Manufacturing Co. a fast wooden yacht, the Stiletto, 86 ft. 6 in. long, 11 ft. beam, and about 31 tons displacement, with a speed of 18 knots. After some changes were made this vessel was fitted as a torpedo-boat, for use in experimental work at the torpedo station in Newport, where she is still in service. The first modern torpedo-boat to be added to the navy was the Cushing, built by the Herreshoff Manufacturing Company, for the Navy Department, and commissioned in 1890. She was of galvanized steel throughout, and at the time of her completion, was a good example of current practice. The same year Torpedo-Boat No. 2, the Ericsson, was appropriated for.

In 1894 the work of torpedo-boat construction was taken up in earnest. In July of that year appropriation was made for three boats 160 ft. long and of 140 tons displacement, with a speed of 24.5 knots. The succeeding Congress made provision for three more of still larger size and higher speed. In June, 1896, Congress provided for the construction of three torpedo-boats having a speed of 30 knots, and appropriated $500,000 for the construction of not more than ten torpedo-boats of lower speed. Under this second provision, contracts were entered into by the Navy Department for the construction of three boats having a speed of 22 1-2 knots and four boats having a speed of 20 knots. Of the three 30-knot boats provided for, two are of small size and the third similar to the English torpedo-boat destroyers. The next Congress authorized the construction of three more 30-knot boats, all of the large size designated in the English service as torpedo-boat destroyers. In Table I will be found such particulars as the names of the builders, dimensions, etc., as well as such data of design as are to be had for all these boats. An inspection of the table will disclose the wide variation in design which exists among the boats which we have built and are building. (The table containing this data will be found on the opposite page.)

Of the hundreds of foreign torpedo-boats built and building, there is not the space for a mention of even the most important. In Table II there have been arranged all the available data regarding the dimensions, armament, weights, etc., as well as the general data regarding the machinery and boilers of some of the more prominent of these. It is believed that the data given are accurate, except that the displacements given for some of the English torpedo-boat destroyers are only approximately the displacements on the trials for which the I. H. P. and speed are given.

At the end of the year 1896 the leading maritime powers possessed in serviceable condition, were building, or had projected torpedo-boats in the following numbers and sizes:

| Lengths. | England. | France. | Russia. | Italy. | Germany. | Japan. | Spain. | U. S. |
|---|---|---|---|---|---|---|---|---|
| Less than 100'... | 64 | 28 | 95 | 21 | — | 4 | 5 | 1 |
| 100' to 125' inc... | 57 | 161 | 16 | 40 | 25 | 66 | 12 | 4 |
| 125' to 150' inc... | 39 | 62 | 105 | 110 | 107 | 35 | 28 | 7 |
| 150' to 180' inc... | — | 3 | 4 | 9 | 25 | — | — | 6 |
| More than 180'.. | 102 | — | 4 | 1 | 11 | 11 | 11 | 4 |
| Totals..... | 262 | 254 | 224 | 181 | 168 | 116 | 56 | 22 |

The figures illustrate the growth in a score of years of a branch of naval armament and the advance in ideas which has been made in that time as to the importance and utility of the torpedo-boat. In order that the extent of the change which has been worked in the torpedo-boat itself in the same period may be the more readily realized, boats of English construction of several of the years of this period have been arranged in Plate I (page 7) in order.

The Naval Architect, arraying the achieve-

TABLE No. I.

DIMENSIONS AND OTHER DATA FROM TORPEDO-BOATS OF THE UNITED STATES.

| Name. | Date. | Length. | Beam. | Draught. | Displacement. | Armament. | Torpedo Tubes. | Designed speed. | Trial speed. | Designed I. H. P. | Trial I. H. P. | Weight of hull. | Weight of propelling machinery. | Trial load. | Bunker capacity. | Economical radius. | Diameter of Cylinders. H. P. | Diameter of Cylinders. I. P. | Diameter of Cylinders. L. P. | Stroke. | Revolutions. | No. of boilers. | Kind of boilers. | Grate surface, each boiler. | Heating surface | Boiler pressure. | Weight of engine, condenser, etc. | Weight of boiler, water and fittings. | No. of screws. | No. of blades. | Pitch. | Diameter. | Blade area. | Slip per cent. | Piston speed. | Remarks. | Builders. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cushing | 1890 | 137'.5 | 14'.25 | 4'.875 | 105.3 | 3 1-pdrs. | 1 18-in. bow 2 on deck | 22 | 22.53 | 1750 | Est'd 1760 | 33.7 | 54.5 | 17.3 | 39 | | Quadruple expansion 11½" | 16" 24½" Quadruple. 22½" | 22½" Quadruple. 22½" | 15" | 375 | 2 | Thornycroft. | 38.65 | 2253 | 235 | 34.0 | 20.50 | 2 | 4 | 8'.417 | 4'.3" | 9.3 projected. 6.3 helicoidal. | 27 | 935 | | Herreshoff Mfg. Co. |
| Ericson | 1891 | 150' 0" | 15' 6" | 4' 9" | 120 | 4 1-pdrs. | 3 18-in. 2 deck } 18" | 24 | | 1800 | | 49.20 | 58.46 | 17.5 | 35 | | 11½" | 19½" | 30" 25" 25" | 16" | 385 | 2 | Thornycroft. | 42.5 | 2369 | 250 | 31.69 49.50 | 19.20 34.30 | 2 | 3 | 7' 8" | 4' 9" | 8.5 helicoidal. | 19.84 | 1056 1037 | | Dubuque Iron Works. |
| Nos. 3, 4, and 5 | 1895 | 160' 0" | 16' 0" | 5' 0" | 143.9 | 3 1-pdrs. | 3 18-in. | 24½ | 24.58 28.38 | 2000 | | 93.1 | 50.82 | 30.5 | 44 | | 12" | 19½" | 25" | 16" | 393.77 398 | 3 | Mosher. | 45.5 | 2630 | 240½ | 31.69 49.50 | 19.20 34.30 | 2 | 3 | 7' 10" | 5' 2" | 9.68 projected. 7.1 helicoidal. | 19.84 | 1056 1037 | | Columbian Iron Works. |
| No. 6 | 1895 | 175'.5 | 17' 6" | 6' 9" | 185 | 3 1-pdrs. | 3 18-in. | 27½ | 28.38 | 3400 | | 96.5 Est'd | 76.8 Est'd | 29½ | 60 | | 16" | 25" | 25" | 16" | 398 | 3 | Du Temple. | 53½ | 2710 | 250 | 49.50 Est'd | 34.30 Est'd | 2 | 3 | 9' | 5' 4" | 11.32 | | | | Herreshoff Mfg. Co. |
| No. 7 | | | | | | | | | | | | 95 Est'd | 92.0 Est'd | | | | | | | | | | | | | | 33.50 Est'd | | | | | | | | | |
| No. 8 | 1895 | 176'.0 | 17'.0 | 5' 6" | 184 | 4 1-pdrs. | 3 18-in. | 26 | | 3300 | | 96.5 | 78.20 | 27.32 | 60 | | 14½" | 23" | 25½" | 18" | 395 | 3 | Mosher. | 47 | 2630 | 250 | 49.50 | 34.30 | 2 | 4 | 8' 8" | 6' | | | | Not yet completed. Elements given are as designed. | Moran Bros. |
| Nos. 9 and 10 | 1896 | 147' | 16' 4½" | 4' 7½" | 143.3 | 4 1-pdrs. | 3 18-in. | 30 | | 4200 | | 44.55 | 78.20 | 20.39 | 33 | | 17½" | 24½" | 25½" | 21" | 340 | 2 | Normand. | 55 | 2580 3400 outside | 300 | Est'd 47.55 | Est'd 30.65 | 2 | 3 | 10' 8" | 6' 4" | | | | do. | Bath Iron Works. |
| No. 11 | 1896 | 215' | 20' | 6' | 240 | 6 6-pdrs. | 3 18-in. | 30 | | 5600 | Est'd 720 | 55 | | 35 | 80 | | 20" | 29" | 30" | 18" | 400 | 3 | Thornycroft. | 66 | 4000 | 240 | Est'd 63.51 | Est'd 56.49 | 2 | 3 | 8' 9" | 6' 9" | 6.9 projected. 8.5 developed. | | | do. | Union Iron Works. |
| Nos. 12 and 13 | 1896 | 146' | 14' 6" | 5'.17 | 110.4 | 3 1-pdrs. | 3 18-in. | 29½ | | 1750 | Est'd 57.1 Est'd 48.7 | 42.6 Est'd 36.6 | | 20.0 | 40 | | 15" | 22½" | 22½" | 15" | 395 | 2 | Thornycroft. | 71 | 2426 | 250 | Est'd 30.32 | Est'd 26.78 | 2 | 3 | 7'.3" | 4' 10½" | | | | do. | Wolff & Zwicker. |
| No. 14 | 1896 | 139' | 15' | 4' 1" | 103 | 1 1-pdr. | 2 18-in. | 20 | | 850 | | 14.3 | 21.7 | 10½ | 8 | 1000 | 12½" | 19½" | 25" | 13½" | 400 | 1 | Du Temple. | 38 | 1850 | 235 | | | | | | | | | do. | Herreshoff Mfg. Co. |
| No. 17 | 1896 | 101' 6" | 12' 6" | 4' 3" | 65 | 1 1-pdr. | 2 18-in. | 20 | | 850 | | | | | | | 12" | 19½" | 22½" | 16" | 350 | 2 | | | | | | | | | | | | | do. | Herreshoff Mfg. Co. |
| No. 18 | 1896 | 101½' | 12' 6" | 4' 3" | 65 | 1 1-pdr. | 2 18-in. | 20 | | 850 | | | | | | | 12" | 19½" | 22½" | 16" | 350 | 2 | | | | | | | | | | | | | do. | Hillman & Sons. |
| No. 19 | 1897 | 225' | 21'.3 | 6' 6" | 340 | 6 6-pdrs. | 2 18-in. | 30 | | 7200 | | | | 60 | | | 21".5 | 32".5 | 34" 34" | 18" | 400 | 4 | Thornycroft. | 67.8 | | 240 | | | | | | | | | do. | Columbian Iron Works. |
| No. 20 | 1897 | 191' 8" | 20' 2" | 5' 0" | 247.5 | 4 6-pdrs. | 2 18-in. | | | | | | | 41.6 | 131 | | 19".5 | 31".75 | 35" 35" | 18" | | 2 | | | | | | | | | | | | | do. | Harlan & Hollingsworth. |
| No. 21 | 1897 | 205' | 18' 3" | 6' 0" | 235 | 4 6-pdrs. | 2 18-in. | | | 5600 | | | | 41.5 | | | 20" | 29" | 30" | 18" | 400 | | Seabury | | | 245 | | | | | | | | | do. | Wolff & Zwicker. |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Gas Engine & Power Co. |

ments in torpedo-boat construction of the last two decades, is justified in his feeling of self-satisfaction at the results which have attended his struggles with difficulties and the proofs which they bring of his ability, by the careful and scientific application of his skill, to overcome great difficulties. The Marine Engineer may look with deserved pride upon the giant strides which he has made in these few years in passing from the 90 horse-power compound engine and locomotive boiler of the first torpedo-launch, to the 6,000 horse-power quick-running engine and the water-tube boilers of the latest torpedo-boat destroyers, as irrefutable testimony to his energy and ability. Satisfactory as this progress is from an engineering point of view, those who would look upon the torpedo-boat as a weapon provided for a definite serious purpose must investigate the progress in its bearing upon the efficiency of the boat for that purpose. Assuming the desirability of the latest types for the nation originating them, is there anything in our own circumstances which makes advisable the acceptance of the same types by us?

The object for which torpedo-boats are constructed is the destruction of vessels of the enemy. It is intended that a vessel costing a few thousands of dollars and manned by a handful of men shall attempt the destruction of vessels costing hundreds of thousands of dollars, carrying hundreds of men. The condition of equalization which comes in to give the immeasurably weaker unit a chance of success against the cruising ship is the secrecy of action possible under cover of darkness or fog. For the secrecy of action and immunity from discovery upon which success is contingent, the torpedo-boat depends upon the visible surface which she presents. It is her small size which enables her to creep upon her antagonist and deal the deciding blow. Early discovery means to her failure always, and probable destruction. The protection of the torpedo-boat lies primarily in her size. In her secondary role of protector of the fleet against torpedo-boat attack, she is also dependent upon her size for success. To destroy, she must discover, and to discover the torpedo-boats making a stealthy approach it is necessary that the size and visible surface of the guarding boat should not be so greatly superior to that of the attacking boats that they may make her out in time to avoid her. The modern torpedo-boat destroyer, by its large size and attendant visibility, will, under the circumstances which are admitted as possible for torpedo-boat attack, defeat its own purpose.

The purposes for which we require torpedo-boats naturally divide them into two large classes—the seagoing and the harbor or coast-defense. This division, while not directly recognized in the classifications of torpedo-boats by the various nations, is accepted in the division of duties to which boats already constructed are considered assignable, and is implied in all the

# TABLE No. II.

## DIMENSIONS AND OTHER DATA FROM RECENT FOREIGN TORPEDO-BOATS.

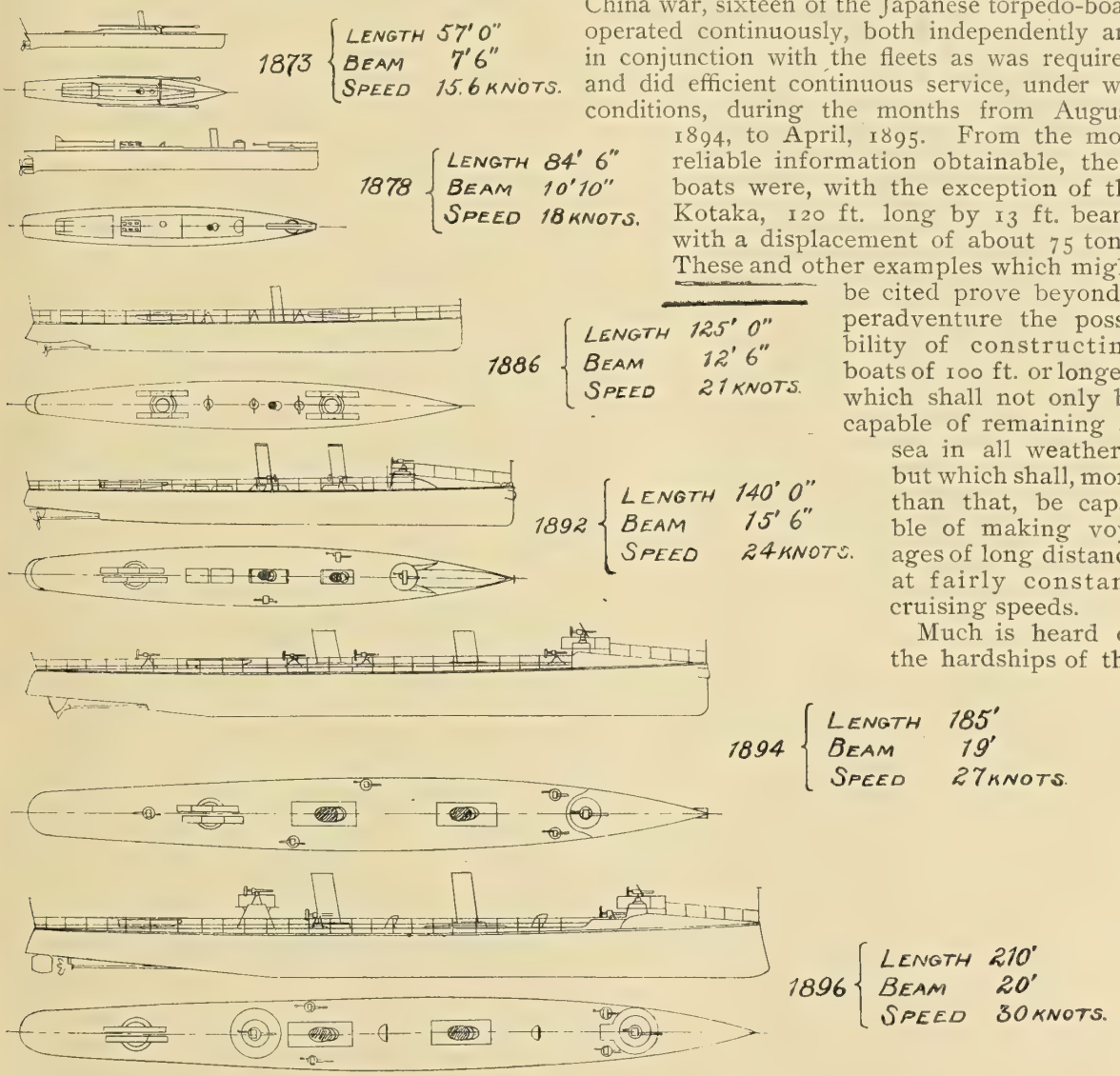
| Name | Date. | Nation. | Length. | Beam. | Draught. | Displacement. | Armament. | Torpedo Tubes. | Designed speed. | Trial speed | Designed I. H. P. | Trial I. H. P. | Weight of hull. | Weight of propelling machinery. | Trial load. | Bunker capacity. | Economical radius. | Diameter of Cylinders. H. P. | I. P. | L. P. | Stroke. | Revolutions | No. boilers. | Kind of boilers. | Grate surface, each boiler. | Heating surface. | Boiler pressure. | Weight of engines, condenser, &c. | Weight of boiler, water and fittings. | No. of screws. | No. of blades. | Pitch. | Diameter. | Blade area. | Slip per cent. | Coal per I. H. P. per hour. | Patrol speed | Remarks | Builders. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Tons. | | | Knots. | Knots. | | | Tons. | Tons. | Tons. | Tons. | | | | | | | | | | Sq. ft. | Sq. ft. | Lbs. | Tons. | Tons. | | | | | | | | | |
| Aluminum (second class). | 1894 | France | 60′ | 9′ 3″ | | 9.5 | | | | 20.55 | | 300 | 2 | 4.5 | 3 | | | Compound. | | | | 591 | 1 | Yarrow | | 500 | 185 | 1.5 | 3.0 | 1 | | | | | | | Material used aluminum alloy of 14 tons per sq. in. tensile. | Yarrow & Co. |
| No. 126. | 1890 | France | 118′ | 13′ 1½″ | 3′ 9½″ | 69.98 | 2 1-pdrs, | 2 18-in. | 20 | 20.975 | 900 | 1025 | 26.68 | 29.32 | 14.0 | 10 | | 17″.3 | | 27″.74 | 17″.3 | 350 | 1 | Locomotive. | 17.0 | 1387 | 142.2 | 13.64 | 15.68 | 1 | | | | | | 1.907 at 20 knots. 1.25 at 10 knots. | 1010 | | Normand. |
| No. 127. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. 128. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. 149. | 1892 | France | 118′ | 13′ 1½″ | 3′ 10″ | 74.55 | 2 1-pdrs. | 2 18-in. | 23 | 24.51 | | 1333.5 | 28.85 | 27.23 | 18.47 | 14 petr'm | | 16″ | 23″ | 31½″ | 18″ | 340 | 1 | Normand | 35.5 | 1895 | 170.6 | 14.92 | 12.31 | 1 | 3 | 7′.77 | 6′.66 | | | | 1020 | | Normand. |
| Sunderland | 1890 | | 137′ | 13′ 9″ | 4′ 0″ | 84 | | | | 21.03 | | 1203 | | | | 13.8 | | 15″ | 22″ | 33⅛″ | 18″ | 352 | 1 | Locomotive | | 2173.5 | 155 | | | 1 | | | | 26.6 | | 1056 | Burns liquid fuel | Doxford & Sons. |
| | | | | | | | | | | 25 5 | | 1973 | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aquilon | 1895 | France | 137′ 8″ | 14′ 76″ | 4′ 43 Hull amid. | 118 t | 2 47 mm | 2 | | 14 0 | | 345 | | | 50 2 | | 15½ | | | | | | 2 | Normand | 33.35 | 1539 | 170 | 27.41 | 22.73 | 2 | | 7′.9 | 5′ 66″ | | | | | | Normand. |
| Ariel | 1895 | France | 137′ 8″ | 14′ 39″ | 4′ 42 Hull amid | 118.84 | 2 3-pdrs. | 1 bow 1 deck 1 bow | | 25.87 | | 3682 est. | 38.78 | 50.14 | 29.92 coal | | | 15″.35 | 20″.47 | 29″.76 | 16″.3 | | 2 | Normand | 33.35 | 1539 | 170 | 27.41 | 22.73 | 2 | | 7′.9 | 5′ 66″ | | | | | Rudder forward screws. | Normand. |
| Flibustier | 1894 | France | 137′ 8″ | 14′ 39″ | 4′ 53 | 123 34 | 2 47 mm. | 1 deck | | 25 66 | | 2466 | | 51. | 17 | | | | | | | | 2 | Normand | 31 35 | 1539 | | | | 2 | | | | | | | | | Doxford & Sons. |
| Lancier | 1895 | France | 137′ 8″ | 14′ 39″ | | 117.88 | 2 3-pdrs. | 1 bow 1 deck | | 25.79 | | 2367 | 39.85 | 47.85 | 30.18 | | | 15″.35 | 20″.47 | 29″.76 | 16″.3 | | 2 | Du Temple. | 40.69 | 1403 | 170 | 27.77 | 20.08 | 2 | | 7′.9 | 5′ 66″ | | | | | Rudder abaft screws. | Normand. |
| Eclair | 1892 | France | 143′ | 14′.7 | Aft 8.23 | 104 | 2 1-pdrs. | 1 bow 1 deck | 20.5 | 21.5 21.7 21.6 | 1200 | | | | | 14.5 | 2165 | 17″.3 | 25″.2 | 39″.3 | 16″.5 | 317 315 317 | 2 | Thornycroft | 29 S | 1825 | 185 | | 19.86 | 1 | | | | | | 872 | | Forges et Chantier de la Mediterranée, La Seyne. |
| Orage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Kabyle | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Chevalier | 1894 | France | 144′ 3″ | 14′.4 | | 111.53 | 2 1-pdrs. | 3 18-in. | | 27.22 | 2700 | 2959 | 42.02 | 51.01 | 18.5 | 17 | 5300 | | | | | 360.6 | 2 | Du Temple. | 43 | 1642 | 213 | 19.68 | | 2 | | 9′.05 | 5′.85 | | | At full speed 1.99 | | Normand. |
| Forban | 1894 | France | 144′ 3″ | 14′ 5″ | | 124.8 | 2 1-pdrs. | on deck 2 14-in. on deck | 30 | 31.03 | 3250 | 3945.2 | 45.39 | 62.67 | 16.74 | 15 | 2360 | 16″.14 | 22″.83 | 33″.07 | 18″.11 | 365 | 2 | Normand | 44.11 | 1035 | 213.3 | 36.33 | 26.34 | 2 | 3 | 10′.00 | 5′.9 | | | At full speed 1.51 | 1100 | | Normand. |
| No. 91 | 1894 | England | 142′ 6″ | 15′.5 | | 129 | 3 3-pdrs. | 3 18-in. | 23 | 23.71 24.52 | 2600 | | | | | 24 | | 19″ | 27″ | 27″ 27″ | 16″ | 380 | 2 | Thornycroft | | 220 | | | 8′ 9″ | 1 | | 8′ 9″ | 6′ 2″ | 13.5 | | | 1013 | | Thornycroft. |
| No 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Viper | 1895 | Austria | 147′ 6″ | 14′ 9″ | | 120 | 3 3-pdrs. | 2 18-in. | 24 | 26.64 | | 2000 | | | | 26 | 30 | 18″ | 24″ | 36″ | 18″ | 379.9 | 2 | Yarrow | 35 | 1868 | 174 | | 18 | 1 | | | | | | | 1140 | | Yarrow. |
| Natter | 1896 | Austria | 150 5 | 17 38 | 8 79 | 151 | 2 3-pdrs | 1 18-in | 23 5 | 26 5 | 2260 | | | | | 25 2 | 29 5 | | | | | | 2 | Thornycroft | | | | | | 1 | | | | | | | 1066 | Has auxiliary bow rudder | Schichau. |
| Injeniero Hyatt | 1896 | Chili | 152′.5 | 15′.25 | 3 4½″ | | 3 1-pdrs. | 2 18-in. | 25.5 | 26.797 | 2000 | | | | 27 25 | 40 | 2500 at 10 knots | 18″ | 26″ | 39″ | 18″ | 355.4 373 | 2 | Yarrow | | | 175 | | 18 | 1 | | 7 6″ | | | | | 1119 | Four are to be bolted up at works, then taken apart and shipped to Chili by steamer. | Yarrow. |
| Five First Class. | | | | | | | | 1 bow | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mousquetaire | 1893 | France | 154′ | 15′ 7″ | 7′ 0″ | 125 | 2 1-pdrs. | 1 deck | 24.5 | 24.77 | 2100 | | | | 18 | 18 | 2700 | 15″.8 | 23″.6 | 35″.5 | 15″.8 | | 2 | Thornycroft. | 41.2 | | | | 32 | 2 | 3 | 8′.503 | 5′.512 | | | | 971 | | Forges et Chantier de la Mediterranée Le Havre. |
| (Unnamed) | 1896 | Italy | 154′.2 | 16′.92 | 3′.95 | 133 | | | 25 | | | 2466 | | | | | | | | | | | | | | | | | | | | | | | | 1011 | | Odero. |
| Havoc | 1893 | England | 180′ | 18′ 6″ | | 215 | 1 12-pdr. 3 6-pdrs. | 1 bow 2 deck | 26 | 26.78 | | 3500 | | | 35 | 60 | 3500 | 18″ | 26″ | 39½″ | 18″ | 362 | 2 | Locomotive. | 50 | 2500 | 165 | | 54 5 35 each boiler | 2 | 3 | 8′.0 | 6′ 6″ | Developed 1700 | 9 | | 1086 | At 10 knots burns 3½ cwt. per hour. | Yarrow. |
| Hornet | 1894 | England | 180′ | 18′ 6″ | | 204 | 1 12-pdr. 3 6-pdrs. | 1 bow 2 deck | 27 | 27.03 | | 4000 | | | 35 | 60 | | 18″ | 26″ | 39½″ | 18″ | 395 | 8 | Yarrow | 20.6 | 1027 | 172 | | 43 | 2 | 3 | 8′.0 | 6′ 6″ | Developed 1700 | 11 | | 1185 | Identical with Havoc, except for boilers. | Yarrow. |
| Decoy | 1893 | England | 185′ | 19″ | 6′ 25 6′.28 | 240 | 1 12-pdr. 3 6-pdrs 1 12-pdr. 4 6 pdrs. | 1 bow 2 deck | 27 | 27.76 27.79 | 3500 | 4049 4409 | | 115 | 35 | | | 19″ | 27″ | 27″ 27″ | 16″ | 364 379 | 3 | Thornycroft. | 63 | 2630 | 198 200 | 66.5 | 48.5 | 2 | 3 | 8′ 9″ | 6′ 2″ | 13.5 | 15 | | 971 1011 | | Thornycroft. |
| Sokol | 1895 | Russia | 190′ | 18.5 | 7′ | 240 | 2 16-in. | 2 deck | 29 | 29.76 | 4000 | 3700 | | | 30 | 60 | | 18″ | 26″ | 39½″ | 18″ | 405 | 8 | Yarrow | | | | | | | | | | | | 1215 | | Yarrow. |
| Starfish | 1895 | England | 190′ | 19′ 0″ | 5′ 7″ | 252 | 1 12-pdr. 3 6-pdrs. | 1 bow 2 deck | 27 | 28.0 | | 4510 | | 104 75 | 30 | 70 | At 13 knots 2800 | 18″ | 27″ | 42″ | 18″ | 407 | 4 | Blechynden | 42.5 | | 200 | | | | | | | | 2.5 at 28.0 1.635 at 13 knots. | 1221 | | Naval Construction and Armament Co. |
| Entre Rios | 1895 | Argentine Republic | 190′ 8″ | 19′ 6″ | 5′ | 250 | 1 14-pdr. 3 6-pdrs. 2 Maxim. | 1 bow 2 deck | 26 | 26.80 26.71 26.70 | 4000 | | | | 35 | 80 | | 18″ | 26″ | 39½″ | 18″ | 365 355 | | | 147 | | | | 40.5 | 2 | 3 | 8′.0 | 7′.0 | | | | 1095 1085 | | Yarrow. |
| Misiones | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Sides and deck over machinery and boilers are of ¼″ steel. | |
| Corrientes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Santa Fé | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Handy | 1894 | England | 194 | 19′ 4½ | 6 35 | 225 | 1 12-pdr. 5 6-pdrs. | 1 bow 2 deck | 27 | 27.00 27 07 27.14 | | 4451 4143 4345 | | | 30 | | | 18½ | 27½ | 32 | 18 | 390 | 3 | Thornycroft | 63 | 3163 | | | | 2 | | | | | | 1170 | | Fairfield Shipbuilding & Engineering Co. |
| Hart | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Hart reported to be fitted with Holden system of burning petroleum. | |
| Hunter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lynx | 1894 | England | 194′ | 19′ 3″ | 5′ 5″ | 220 | 1 12-pdr. 5 6-pdrs. | 2 18-in. deck. | 27 | 27.15 27.61 | | 4507 | | 123.61 | 30 | 70 | | 19″ | 29″ | 43″ | 18″ | 363 | 4 | Normand | | | 175 | 59.4 | 64.2 | 2 | | | | | | | 1089 | | Laird. |
| Ferret | | | | | | | 1 12-pdr. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Haughty | 1895 | England | 196′ | 19′ | 5′ | 231 | 5 6-pdrs. | | 27 | 27 5 | | 3221 | | | | | | | | | | 363 4 | | Yarrow | | | 135 | | | | | | | | | | 1101 | | Doxford & Sons. |
| Janus | 1895 | England | 200′ | 19′.75 | 6′.5 | 247 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | 27.31 27.9 27.9 | | 3789 4000 3366 | | 120.0 Ex. | 30 | | | 18″ | 27″.5 | 42″ | 18″ | 397.4 371.2 360.2 | 4 | Reed | | | 193 192 197 | 49.0 | 70.69 | 2 | | | | | 2.54 at full speed | 1103 1085 | | Palmer's Shipbuilding & Iron Co. |
| Lightning | | | | | | | | | | | | | | water | | | | | | | | | | | | | | | | | | | | | | | | |
| Porcupine | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Spitfire | 1896 | England | 200′ | 19′ | 5′ 2½″ 7 5″ | 265 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | 27.461 27.12 | 4000 | 4506 4570 | | | 30 | | | 18½ | 27½ | 28″ | 18″ | 398 399 | 8 | Yarrow | 22½ | 1063 | 195 203 | 53.9 | 50.9 | | | | | | 1.97 at 13 knots. | 1194 1197 | | Armstrong, Mitchell & Co. |
| Swordfish | | | | | | 279 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Salmon | 1895 | England | 200′ | 19′ 6″ | 6′ 3″ | Load 253 | 1 12-pdr 5 6-pdrs. | 2 deck | 27 | 27.56 | | 3699 | | 125 | 30 | | | 19½ | 28½ | 43″ | 18″ | 355 | 8 | Yarrow | | | 177 | | | 2 | 3 | | | | 1.8 at 13 knots. | 1065 | | Earle Ship & Engine Co. |
| Snapper | | | | | | 278 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Opossum | 1895 | England | 200′ | 19′ | 6′ 7″ | 282 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | 27.131 27.171 27.581 | | 3895 4055 4174 | | | 30 | | | 18½ | 28″ | 42″ | 18″ | 343 348 351 | 8 | Yarrow | 21 | 1063 | 192 194 188 | | 13.0 | 2 | 3 | 9 | 7 | | | | 1029 1044 1053 | | R. & W. Hawthorn. |
| Ranger | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sunfish | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conflict | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wizard | 1896 | England | 200′ | 20′ | 6′ 0″ | 303 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | | 4500 | | | | 30 | | | 19½ | 28½ | 30⅝ 30½ | 18″ | | 3 | White | 70 | 3750 | 225 | | | | | | | | | | 1188 | | Thames Iron Works. |
| Teaser | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Zebra | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Rocket | 1895 | England | 200′ | 19′.5 | 5′.25 | 235 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | 27.4 27.6 | | 4300 4350 | | | 30 | | | 18½ | 26½ | 40½ | 18″ | 396 401 | 4 | Normand | 41 | 2150 | 188 184 | | | 2 | | | | | | | 1188 1203 | | J. & G. Thompson. |
| Surly | | | | | | | | | | 28.05 | | 4175 | | | | | | | | | | 405 | | | | | | | | | | | | | | 1215 | | |
| Shark | | | | | | | | | | 27.84 | | 4306 | | | | | | | | | | 396 | | | | | | | | | | | | | | 1073 | | |
| Ardent | 1895 | England | 201′ 6″ | 19′ | 6′.67 | 280 | 1 12-pdr. 5 6-pdrs. | 2 deck | 27 | 29.08 28.14 | | 4487 4156 | | | 30 | | | 19½ | 27″ | 27″ 27″ | 16″ | 410 374 | 3 | Thornycroft | 63 | 3168 | | | | 2 | | | | | 1.53 at 13 knots. | 1093 1000 | | Thornycroft. |
| Boxer | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bruiser | | | | | | | | | | 30.112 | | 5620 | | | | | | | | | | 398 | | | | | | | | | | | | | | 1191 | | |
| Desperate | 1896 | England | 208′ | 19′ 6″ | 6′ 0″ | 272 | 1 12-pdr. 5 6-pdrs. | 2 deck | 30 | 30.155 30.093 | 5400 | 5654 5657 | | 127.95 | 35 | | | 20″ | 29″ | 30″ 30″ | 18″ | 398 394 392 | 3 | Thornycroft. | 66 | 4000 | 209 205 | 61.49 | 66.45 | | | | | | 2.43 at 30 knots. | 1182 | 1.67 lbs. per I. H. P. at low speed. | Thornycroft. |
| Fame | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Foam | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mallard | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Quail | | | | | | | | | | 30.56 | | 6057 | | | | | | | | | | 365 | | | | | 214 | | | | | | | | | | | |
| Sparrowhawk | 1896 | England | 210′ | 19′ 6″ | | 300 | 1 12-pdr. 5 6-pdrs. | 2 18-in. deck | 30 | | 6000 | | | 144.3 | 35 | 80 | | 21″ | 32⅛″ | 48″ | 18″ | 363 | 4 | Normand | | | 208 | 68.6 | 75 7 | 2 | | | | | 2.64 at full 1.64 at low speed | 1035 | | Laird. |
| Thrasher | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Virago | | | | | | | | | | 30 17 | | 6425 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Star | | | 220′ | 20′ | | 319 | | | | 30 05 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Whiting | 1896 | England | 2 | 20′ | | 300 | 5 6-pdrs. | 2 deck | 30 | 30 167 | 5900 | 6231 | | | 35 | | | 18″ | 27″.5 | 42″ | 18″ | 393 | 4 | Reed | | | | | | | | | | | | | | Palmer's Shipbuilding & Iron Co. |
| Chanos | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cano | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

classifications. The characteristics of the boats for the two purposes are essentially as different as are the characteristics of the sea-going battleship and the coast defense monitor.

### The Sea-Going Torpedo-Boat.

It is imperative that the sea-going torpedo-boat shall be seaworthy—that is, capable of remaining safely at sea in all such weathers as may reasonably be anticipated. Since the size of the boat has so vital a bearing upon its efficiency, it is important to consider what limitations are placed upon size by the necessity of seaworthiness, in order that it may be determined whether the size of boat consistent with the other characeristics required is consistent with this demand. In 1879, the Russian torpedo-boat Batoum (length 100 ft., beam 12 ft. 6 in., displacement 50 tons), made the voyage from London to Nikolaief, a distance of 4,800 miles, with a crew of three officers and nine men, at an average speed of 11 knots. In the following year, four boats for the Argentine Republic, of the same length and slightly less displacement, made the voyage from Plymouth to Buenos Ayres, under sail, with little difficulty, one of the boats requiring 72 days for the passage. In 1890 the English boats No. 61 and No. 62 (length 125 ft., beam 13 ft., displacement 75 tons), convoyed by the storeship Tyne, made, under their own steam, the voyage from Plymouth across the North Atlantic, encountering severe gales, fog and icebergs. Since that time boats of about the same size have been sent by the English naval authorities under their own steam from England to their naval stations in Australia, Hong Kong, Singapore, India, and the Mediterranean. Boats for Japan, China, and South American states have made the voyages from the European yards at which they were built to the ports of the countries to which they belong. During the Japan-China war, sixteen of the Japanese torpedo-boats operated continuously, both independently and in conjunction with the fleets as was required, and did efficient continuous service, under war conditions, during the months from August, 1894, to April, 1895. From the most reliable information obtainable, these boats were, with the exception of the Kotaka, 120 ft. long by 13 ft. beam, with a displacement of about 75 tons. These and other examples which might be cited prove beyond a peradventure the possibility of constructing boats of 100 ft. or longer, which shall not only be capable of remaining at sea in all weathers, but which shall, more than that, be capable of making voyages of long distance at fairly constant cruising speeds.

Much is heard of the hardships of the


1873 LENGTH 57' 0" BEAM 7' 6" SPEED 15.6 KNOTS.
1878 LENGTH 84' 6" BEAM 10' 10" SPEED 18 KNOTS.
1886 LENGTH 125' 0" BEAM 12' 6" SPEED 21 KNOTS.
1892 LENGTH 140' 0" BEAM 15' 6" SPEED 24 KNOTS.
1894 LENGTH 185' BEAM 19' SPEED 27 KNOTS.
1896 LENGTH 210' BEAM 20' SPEED 30 KNOTS.

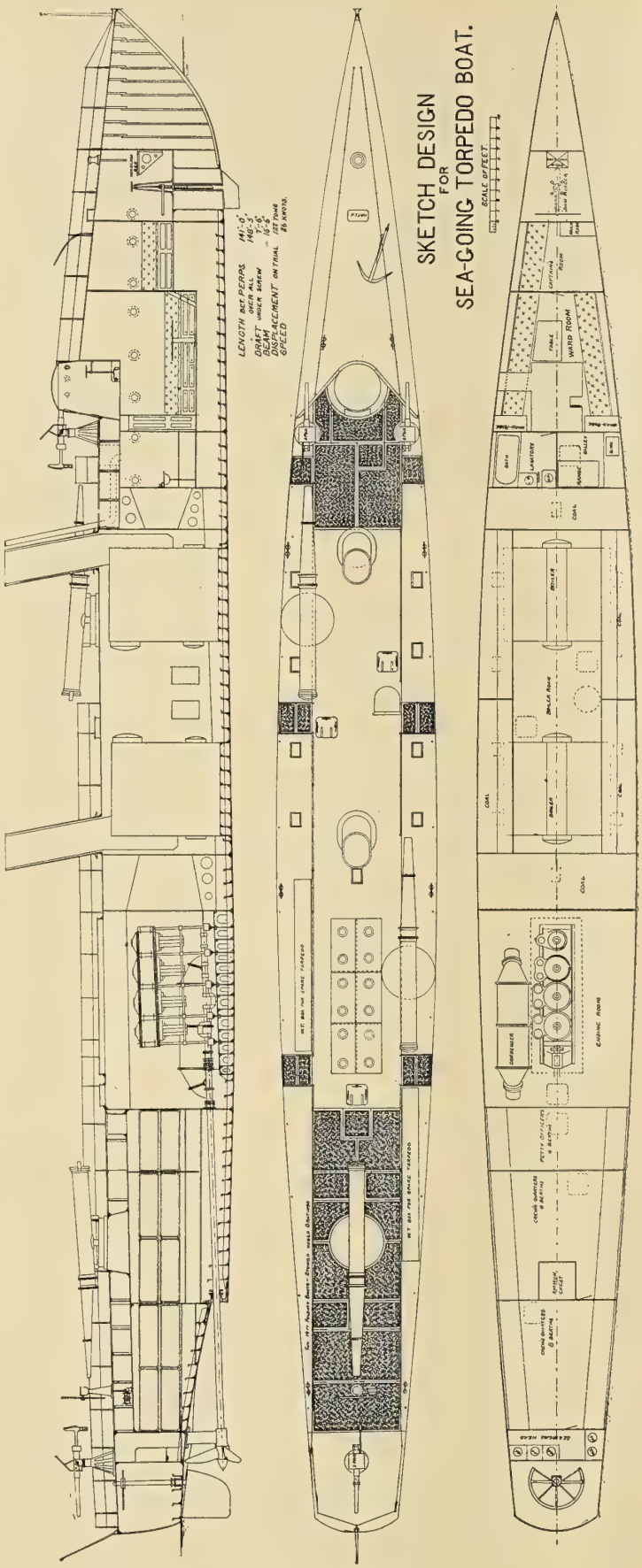
SKETCHES SHOWING GROWTH, IN SIZE AND SPEED, OF THE TORPEDO BOAT.

crews of sea-going torpedo-boats and of the impossibility of their long sustaining the fatigue, etc., of the life. The remedy for this must lie in special training of men for this service. The state of Massachusetts alone sends out more than 40,000 men who spend a large portion of each year at sea in fishing vessels, the average displacement of which is less than 50 tons, whaling vessels and steam trawlers being included in making up the average. No one who has seen the usual fishing vessel and who knows the provisions made for the crew of a torpedo boat can say that, for men habituated to life at sea in a small vessel, the lot of the torpedo boat crew is less happy than that of the crew of the deep-sea fishing vessel.

The size of the sea-going torpedo-boat may then be fixed by the considerations as to the qualities which it is desirable to embody in its design, with the certainty that, due regard being had for stability, it may be made seaworthy and habitable so long as the vessel determined by these considerations is not less than 100 ft. in length and 50 tons displacement. The sea-going torpedo-boat must be prepared to perform two kinds of duty. It must be capable of making a torpedo attack upon the ships of the enemy, and must be prepared to stand guard over and protect from torpedo-boat attack the ships of its own side. To fill both these roles, it is necessary that it should possess the following features: (1) An efficient torpedo armament. (2) A gun armament sufficiently powerful for an attack upon other torpedo-boats. (3) High speed. (4) Sufficient coal capacity. (5) Good manœuvring qualities.

### TORPEDO ARMAMENT.

Torpedo experts are agreed that the long, 18 in. torpedo is the most desirable for this purpose. There remains to be considered the number of tubes which should be installed. The bow tubes which were at one time generally fitted have been abandoned on account of the interference of the bow wave with the tube and on account of the higher-speed boats running down the torpedo before it could gather way after being fired. Upon English, German, Italian, Russian, and our own first-class boats three training tubes have generally been installed. The Austrian, French, and Spanish boats of the same class, the English torpedo-boat destroyer and the



German division-boat have but two each. There is very little experience upon which to base conclusions as to the necessary number of tubes. Provision for three torpedo tubes with a torpedo for each, and for carrying two additional torpedoes, is in conformity with the views of the greater number of the progressive maritime powers.

GUN ARMAMENT.

The boat requires to be provided with an armament which will enable it to encounter and disable or turn back a boat attacking vessels over which guard is being kept. The 1-pounder gun has been shown to be incapable of stopping a torpedo-boat. The 3-pounder, possessing greater penetration and mining power, will. The guns and the torpedoes will not generally be used at the same time. It is believed that three 3-pounder guns would make a battery which could be manned by the crew of the torpedo-boat, and which would be sufficiently powerful for its purpose.

SPEED.

High speed is necessary in the sea-going torpedo-boat to make it meet three important conditions. The first is that it shall be in a class by itself, capable of refusing engagement with vessels of any other class than its own. The second requires that it shall be capable of approaching and getting away, in a torpedo attack upon ships, with sufficient rapidity to make the attack a success. The third condition is that when standing guard over ships to protect them from the attacks of torpedo-boats it shall be capable of pursuing and engaging these boats. The speed of the fastest cruisers of the world, attained only by a very limited number, is 22 knots, so that a speed in excess of this is required in the sea-going torpedo-boat in order to meet the first condition. The experience upon which to base the limit of speed required by the second condition is not great. The Almirante Lynch and the Almirante Condell attacked and torpedoed the Blanco Encalada without requiring the full 20 to 21 knots of which they were capable. The maximum speed of the Japanese torpedo-boats which operated very successfully during the Japan-China war was 23 knots, and upon two occasions these successfully attacked and torpedoed vessels of the enemy. There seems reason to believe that the speed fixed by the first condition is not too low to be consistent with the second. The third condition requires a consideration of the boats with which our sea-going boats may be expected to contend. Of the more than sixteen hundred serviceable torpedo-boats which are now possessed, are building, or are projected by the nations of the world, there are but 260 having a speed of more than 25 knots. Of these, 153 are of the large size and high speed known in the English service as torpedo-boat destroyers, and 87 more are credited with a speed of but 26 knots. It is believed, therefore, that a speed of 26 knots would be sufficient to make our sea-going torpedo-boat capable of performing any service which is within her province. To produce the power necessary for this speed a single vertical engine possesses several advantages which recommend it for the purpose. It will require a smaller number of men to run it and keep it in order. The first cost of the single engine is very much less than that of two engines for the same power. The economy of the larger unit is superior to that of the smaller. The single engine admits of a roomier and more commodious engine-room than would be possible with a pair of engines in the same space.

COAL CAPACITY.

Ideas vary widely as to the necessary coal capacity which should be given to a sea-going torpedo-boat. It is necessary that, when such boats are acting with a fleet, the embarrassment occasioned by the necessity of their procuring coal shall be reduced to the least possible, by giving them as large a capacity as practicable and making some of the times of requiring coal by the torpedo-boat coincide with the times at which the larger ships of the fleet must seek coal. The normal endurance of our battleships of least endurance is about 7,000 nautical miles. It is not practicable to obtain so great a radius as this in the sea-going torpedo-boat. It is, however, possible to provide in the design of these boats for sufficient coal to steam 3,500 to 4,000 nautical miles at 10 knots. The sea-going torpedo-boat would then require coal with the battleships of least endurance and once in each interval between the coaling of these ships. In connection with this matter of coal capacity, the possibility of torpedo-boats receiving coal at sea from ships should be noted. In the voyage of the English torpedo-boats No. 61 and No. 62, previously mentioned, they received coal as they required it from the storeship Tyne, which accompanied them, the coaling being performed without great difficulty, even during some of the very rough weather which was encountered.

MANŒUVRING QUALITIES.

The service required of the torpedo-boat demands that it should be capable of manœuvring readily in a small space. To offset the disadvantage in this regard which is brought in by the single screw proposed, the fitting of a bow rudder in addition to the usual stern rudder and for use in conjunction with it is suggested. This arrangement has been in satisfactory use upon boats constructed by Normand and Schichau for some years, and has proved satisfactory and productive of considerable improvement over the manœuvring qualities of boats fitted with after rudders only.

A boat embodying the features which have been enumerated would, under the customary trial conditions, with a load of 25 tons, representing the equipment, stores, coal, etc., on board, displace about 120 tons. Sketch plans of a de-

sign for such a boat are given on Page 8. The principal dimensions are:

| | |
|---|---|
| Length on the water line | 141 ft., 0 in. |
| Length over all | 148 ft., 5 in. |
| Maximum beam | 15 ft., 6 in. |
| Draught under screw | 7 ft., 6 in. |
| Displacement (trial) | 127 tons. |
| Speed | 26 knots. |

MACHINERY.

| | |
|---|---|
| A single four-cylinder triple expansion engine: | |
| Cylinders 20 in. x 29 in. by 30 in. and 30 in. | |
| Stroke | 18 in. |
| Revolutions, not more than | 400 |
| Indicated horse-power | 2,700 |
| Two water-tube boilers: | |
| Grate area, combined | 110 sq. ft. |
| Coal capacity | 40 tons. |

Such a torpedo-boat could be constructed under the present industrial conditions for less than $100,000, so that at least two could be built for the cost of each of the largest of the boats which are now under construction for the Navy. In the design outlined in the sketch plans, the reserve of buoyancy is somewhat less than is commonly provided, although still more than 100 per cent of the displacement of the boat fully loaded. Provision is made for performing all the external service of the boat upon a platform which is raised some distance above the deck, so that although the reserve of buoyancy and freeboard are slightly less, the height of the deck upon which service is performed is more than is commonly provided in sea-going torpedo-boats.

**Harbor or Coast Defense Torpedo-Boat.**

Our three thousand miles and more of seacoast, with its miles upon miles of inlets and shallow channels, innumerable small outlying islands, and its many harbors, great and small, at once require the protection and afford unequaled opportunities for the use of coast or harbor defense torpedo-boats. While France has available for this kind of duty one torpedo-boat for every 9 miles of coast line, Russia one for every 10 miles, and Great Britain one for every 17 miles, we, who may at any time be called upon to defend our coasts from the attacks of battleships and cruisers of an enemy, have not a single torpedo-boat specially constructed for this purpose, although there are under construction several which are applicable to it. Of the value, as a means of defense, of a large number of small torpedo-vessels attached to and operating from coast stations as bases, there can be no question. They would attack ships of the enemy approaching the coast, and by their numbers and activity make anchorages on the coast absolutely untenable. Ready refuge in the shallow water of the many inlets or behind outlying islands or points of land would be always open to them.

Boats of this kind require: (1.) An efficient torpedo equipment. (2.) A light gun armament. (3.) The least possible draught. (4.) Good speed in deep and shallow water. (5.) Good manœuvring qualities.

TORPEDO EQUIPMENT.

It is not probable that more than one torpedo attack will be engaged in by this class of boat in each interval during which it is absent from its temporary or permanent base. During the Japan-China war in an attack of Japanese torpedo-boats upon vessels in the harbor of Weihaiwai, which resulted in the sinking of the Ting Yuen, seven participating boats fired eleven torpedoes. In a later attack upon the ships in the same harbor, which resulted in the sinking of the Lai Yuen, the Wai Yuen, and the tender Paufah, four participating boats fired seven torpedoes. There is reason to believe that provision for two torpedo tubes for the long 18 in. torpedo, with one torpedo for each tube, should be sufficient for these boats.

GUN ARMAMENT.

To provide the boat with means of embarrassing and keeping down the fire of an opponent when detached and chased by boats guarding ships which it is attacking, provision must be made for an armament which may be manned by the crews of the torpedo-tubes, and which is capable of a rapid and fairly accurate fire. The machine gun seems to be the best arm for the purpose. A battery of three of these manned by the crews of the torpedo-tubes should be effective.

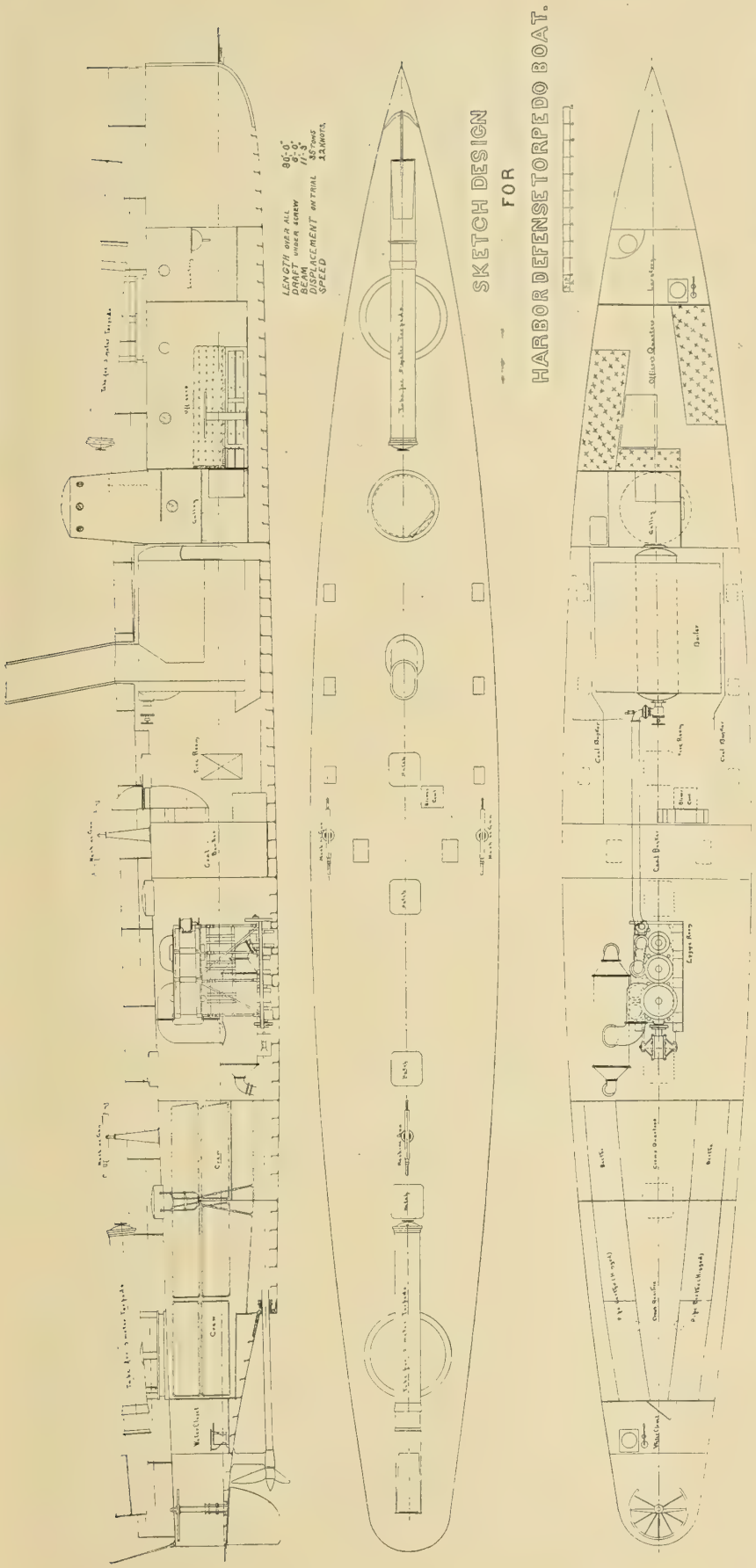
DRAUGHT.

Boats of this class must depend to some extent for their safety upon their ability to elude chasing torpedo-boats and destroyers by running into shallow water. The draught should then be made as small as practicable. Since the change of trim occasioned by high speed in a small boat is accentuated in shallow water, it is necessary to provide for a form of stern which will reduce to a minimum this evil, and it may even be desirable to provide for some trim by the head in still water so that the maximum draught at full speed shall not be increased on account of this change of trim.

SPEED.

The first two of the conditions fixing the limit of speed in the case of the sea-going torpedo-boat (the necessity of being in a class by itself and the necessity for sufficient speed to ensure success in a torpedo attack), hold in the case of the coast or harbor-defense boat. A speed of 22 knots is believed to be consistent with these two requirements.

The operations of such boats as these are necessarily restricted to night or foggy weather, and all the time not occupied in attack is spent within easy reach of coal, which can be had at every port, large and small, along the coast. There is, therefore, not the necessity for large steaming radius which exists in the case of the sea-going torpedo-boat, but full speed may be expected to be more commonly employed than in the case of the sea-going boats. Coal to steam fifteen hours at full speed should provide the means of striking quickly at a point some distance from the base and returning to the base after the attack.




A boat embodying the features here enumerated could be constructed to displace, under trial conditions, with a load of 10 tons representing ordnance, equipment, crew, coal, etc., on board, about 35 tons. Sketch plans of a design for such a boat are given on this page.

The principal dimensions are:

| | |
|---|---|
| Length on water-line.. | 90 ft., 0 in. |
| Maximum beam..... | 11 ft., 3 in. |
| Draught under screw.. | 5 ft., 0 in. |
| Displacement, trial..... | 35 tons. |
| Speed ..... | 22 knots. |

MACHINERY.

A single triple expansion engine:

| | |
|---|---|
| Cylinders, 8 in. x 13 in. by 21 in. | |
| Stroke ..... | 15 in. |
| Revolutions ..... | 425 |
| Indicated horse-power.. | 650 |
| One water-tube boiler: | |
| Grate area..... | 30 sq. ft. |
| Coal capacity..... | 11 tons. |

Under the present industrial conditions such a boat could be built for from $25,000 to $30,000, so that a great number of them could be built at comparatively small cost.

In the preparation of a design for vessels of this class too great attention cannot be given to simplicity and adaptability of the weapon to the character of the men that will be available for duty with it in time of war. The coast or harbor defense torpedo-boat is a reasonable weapon to be placed in the hands of the Naval Reserve and of men who lay aside their peace-time occupations to defend the country.

The machinery in the sketch design is similar to, although more powerful than, that commonly found in small, high speed yachts, and men who are now serving in such yachts would, with a short training under an engineer officer of the Navy, be competent to take and run effeciently the machinery of these small torpedo-boats. The deck could, in part at least, be equally readily recruited from the men who in time of war lay aside peaceful occupations to take up the defense of their country.

## RULES ADOPTED BY NAVY DEPARTMENT FOR RIVETING NAVAL VESSELS.

Instructions were recently issued from the office of Chief Constructor Philip Hichborn, of the Bureau of Construction and Repair of the Navy, for the purpose of standardizing the type of rivets used for naval vessels, together with general rules for spacing of rivets. These instructions will be followed under the direction of the Naval Director in charge, wherever work on naval vessels is in progress, except in such cases as the application of these rules would interfere with work already laid out.

Hitherto this important feature of construction has been left largely to the discretion of the builder, and the result has been a great lack of uniformity in the work on the various war vessels built under contract.

### Rules for Riveting Naval Vessels.

All rivets are to be made from steel of the quality required by the official specifications of the Navy Department.

The various approved types of heads, points, etc., together with table of dimensions, for torpedo boat and ship work, are given on sheet No. 1, on the opposite page.

Rivet holes will be laid off in accordance with rules for sizes and spacing, given in Tables I, II, and III, which follow, together with such modifications, for special cases, as are noted.

All rivet holes through material 1 inch or more in thickness will be drilled, or if punched, will afterwards be reamed to finished size. The increase in diameter of hole due to reaming must be equal to at least one-eighth the thickness of the material. In punching, where possible, holes will be punched from the side which will form the faying surface.

Great care must be taken in punching to prevent holes from coming unfair. Any unfair hole must be reamed out before riveting, and a rivet suitable to the increased size of hole inserted.

Countersinking must be carefully done, following the rules for angle of countersink given on Sheet I. Holes for countersunk heads and points will be countersunk through the plate or shape to within 1-32 in. of the bottom, as nearly as may be in all cases, making it preferably a scant 1-32 in. in the case of thin plates and a full 1-32 in. for heavier plates.

The riveting is to be executed in a careful and workmanlike manner, especial care being taken that the rivets fit the holes accurately and are properly heated for driving, but not burned.

Rivets less than 3-8 in. in dia. will be driven cold. In torpedo boat work, rivets up to 7-16 in. inclusive, may be driven cold, at the discretion of the Superintending Naval Constructor. In this work care will be taken that no joints are riveted up until such precautions have been taken to insure a tight joint, as may have been directed by the Superintending Naval Constructor. Cold riveting is to be preferred for torpedo boat work.

The style of rivet used will be determined by the Superintending Naval Constructor. As a general rule, countersunk heads will be used only where required by mechanical or other special reasons. Wherever practicable, the pan-head rivet will be used, with countersunk points where flush work is required, button or snap points for finished appearance or where rivets are closed by power, and hammered or mashed points elsewhere. Where points are made with a snap tool, or where riveting by power is employed, care will be taken that the points are properly centered. In these cases, and also in the case of hammered points, the aim must be to have the point of adequate strength, following, as near as possible, the dimensions of points given on Sheet I. Care must be taken that snap points are not reduced from the standard sizes by grinding down tools that have been chipped or burred. All pan head rivets not less than 1-2 in. dia. for punched holes should be coned under head, as shown on Sheet I, the rule for punching from the faying surface of plate being carefully observed.

The Superintending Naval Constructor may require any holes to be drilled and bolts turned for them, or he may substitute bolts for rivets, as he considers necessary.

TABLE I.—DIAMETER OF RIVETS.

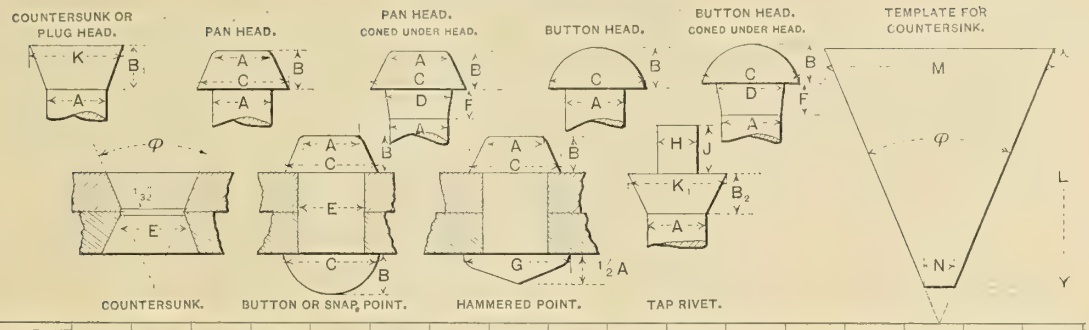
| Weight of plates. | Diameter of corresponding rivets. | Diameter of corresponding rivet holes. |
|---|---|---|
| FOR TORPEDO WORK. | *Inches.* | *Inches.* |
| Up to 3 pounds, exclusive | 1/4 | 9/32 |
| 3 pounds to 6 pounds, exclusive | 5/16 | 11/32 |
| 6 pounds to 7½ pounds, exclusive | 3/8 | 7/16 |
| 7½ pounds to 9 pounds, exclusive | 7/16 | 1/2 |
| 9 pounds to 11 pounds, exclusive | 1/2 | 9/16 |
| 11 pounds to 13 pounds, exclusive | 5/8 | 11/16 |
| FOR SHIP WORK. | | |
| Up to 3 pounds, exclusive | 1/4 | 9/32 |
| 3 pounds to 6 pounds, exclusive | 5/16 | 7/16 |
| 6 pounds, inclusive, to 8 pounds, exclusive | 1/2 | 9/16 |
| 8 pounds, inclusive, to 13 pounds, exclusive | 5/8 | 11/16 |
| 13 pounds, inclusive, to 20 pounds, exclusive | 3/4 | 13/16 |
| 20 pounds, inclusive, to 30 pounds, exclusive | 7/8 | 15/16 |
| 30 pounds, inclusive, to 40 pounds, exclusive | 1 | 1 1/16 |
| 40 pounds, inclusive, to 51 pounds, exclusive | 1 1/16 | 1 5/32 |
| 51 pounds, and above | 1 1/4 | 1 11/32 |

In cases where rivets connect plates of different thicknesses together, the size of rivet indicated for the greater thickness, with corresponding spacing, will be used where strength is required, and that indicated for the lesser thickness where water tightness is a special consideration; always provided that the greater thickness is not more than double the lesser.

Where tap rivets must be used they will be 1-8 in. larger than the corresponding ordinary

## STANDARD RIVETS.

SHEET 1

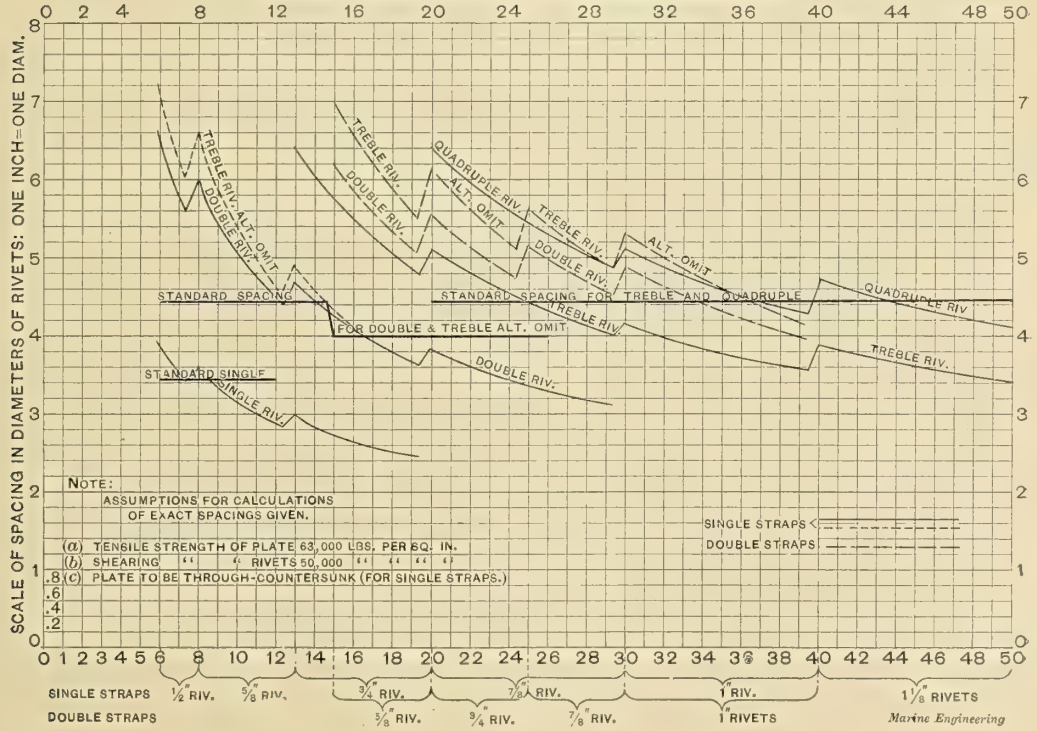



| | PLATE WEIGHT LBS. PER SQ. FT. | A | B | $B_1$ | $B_2$ | C | D | E | F | G | H | K | $K_1$ | J | $\varphi$ | L | M | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TORPEDO BOATS. | UP TO 3 LBS. EX | 1/4" | 3/16" | 3/32" | — | 7/16" | — | 9/32" | — | 1/2" | — | — | — | — | 60° | 2 1/2" | 3 1/64" | 1/8" |
| | 3 " 6 " | 5/16" | 1/4" | 3/16" | — | 1/2" | — | 11/32" | — | 5/8" | — | — | — | — | 60° | " | " | " |
| | 6 " 7 1/2 " | 3/8" | 5/16" | 7/32" | — | 9/16" | — | 7/16" | — | 3/4" | — | — | — | — | 60° | " | " | " |
| | 7 1/2 " 9 " | 7/16" | 11/32" | 1/4" | — | 11/16" | — | 1/2" | — | 7/8" | — | — | — | — | 60° | " | " | " |
| | 9 " 11 " | 1/2" | 3/8" | 5/16" | — | 13/16" | — | 9/16" | — | 1" | — | — | — | — | 60° | " | " | " |
| | 11 " 13 " | 5/8" | 7/16" | 3/8" | — | 1" | — | 11/16" | — | 1 1/8" | — | — | — | — | 60° | " | " | " |
| SHIP WORK. | UP TO 3 LBS. EX. | 1/4" | 3/16" | 3/32" | — | 7/16" | — | 9/32" | — | 1/2" | — | — | — | — | 53° | 2 1/2" | 2 5/64" | 1/8" |
| | 3 LBS. " 6 LBS. " | 3/8" | 5/16" | 3/16" | — | 5/8" | — | 7/16" | — | 3/4" | — | — | — | — | 53° | " | " | " |
| | 6 " 8 " | 1/2" | 3/8" | 1/4" | — | 13/16" | 9/16" | 9/16" | 1/4" | 15/16" | — | 3/4" | — | — | 53° | " | " | " |
| | 8 " 13 " | 5/8" | 7/16" | 3/8" | — | 1" | 11/16" | 11/16" | 5/16" | 1 1/8" | — | 1" | — | — | 53° | " | " | " |
| | 13 " 20 " | 3/4" | 1/2" | 9/16" | 1/2" | 1 3/16" | 13/16" | 13/16" | 3/8" | 1 5/16" | 1/2" SQ. | 1 3/16" | 1 1/4" | 5/8" | 45° | 3" | 2 7/8" | 3/8" |
| | 20 " 30 " | 7/8" | 9/16" | 3/4" | 9/16" | 1 5/16" | 15/16" | 15/16" | 7/16" | 1 1/2" | 9/16" " | 1 3/8" | 1 5/16" | 23/32" | 45° | " | " | " |
| | 30 " 40 " | 1" | 5/8" | 1" | 5/8" | 1 1/2" | 1 1/16" | 1 1/16" | 1/2" | 1 3/4" | 5/8" " | 1 5/8" | 1 1/2" | 23/32" | 37° | " | 2 1/2" | 1/2" |
| | 40 " 51 " | 1 1/8" | 1 1/16" | — | 3/4" | 1 5/8" | 1 3/16" | 1 7/32" | 9/16" | 1 15/16" | 5/8" " | — | 1 5/8" | 23/32" | 37° | " | " | " |
| | 51 LBS. & OVER | 1 1/4" | 3/4" | — | 7/8" | 1 13/16" | 1 5/16" | 1 11/32" | 5/8" | 2 1/8" | 1 1/16" " | — | 1 3/4" | 23/32" | 37° | " | " | " |
| | | ALL RIVETS | PAN & BUTTON HEADS SNAP POINTS | COUNTERSUNK HEADS | TAP RIVETS | PAN & BUTTON HEADS SNAP POINTS | CONED UNDER HEAD | DIAMETER OF HOLES | DEPTH OF CONE UNDER HEAD | HAMMERED POINTS | TAP RIVETS | COUNTERSUNK HEADS | TAP RIVETS | TAP RIVETS | | | | |

## EXACT SPACING OF RIVETS FOR JOINTS OF MAXIMUM STRENGTH.

SCALE OF WEIGHT OF PLATE: 1/4 = ONE POUND PER SQ. FOOT.

SHEET 2


SCALE OF SPACING IN DIAMETERS OF RIVETS: ONE INCH = ONE DIAM.
TREBLE RIV.
ALT. OMIT
DOUBLE RIV.
STANDARD SPACING
FOR DOUBLE & TREBLE ALT. OMIT
STANDARD SINGLE
SINGLE RIV.
QUADRUPLE RIV.
STANDARD SPACING FOR TREBLE AND QUADRUPLE
NOTE:
ASSUMPTIONS FOR CALCULATIONS OF EXACT SPACINGS GIVEN.
(a) TENSILE STRENGTH OF PLATE 63,000 LBS. PER SQ. IN.
(b) SHEARING " " RIVETS 50,000 " " " "
(c) PLATE TO BE THROUGH-COUNTERSUNK (FOR SINGLE STRAPS.)
SINGLE STRAPS
DOUBLE STRAPS
SINGLE STRAPS 1/2" RIV. 5/8" RIV. 3/4" RIV. 7/8" RIV. 1" RIV. 1 1/8" RIVETS
DOUBLE STRAPS 5/8" RIV. 3/4" RIV. 7/8" RIV. 1" RIVETS
Marine Engineering

rivets for the same thickness, excepting taps into heavy forgings or castings, such as stem and stern post, which will be 1-4 in. larger. Where strength is required tap rivets must not penetrate less than 1 dia., and should penetrate 1 1-2 dia. when the thickness of metal will allow it.

TABLE II.—SPACING OF RIVETS.

| Connection. | Number of diameters from center to center. |
|---|---|
| Single-riveted laps and straps | 3½ |
| Double-riveted laps and straps | 4 |
| Treble-riveted laps | 4½ |
| Treble-riveted straps with alternate rivets in third row omitted | 4 |
| Longitudinal seams of plating required to be water-tight | 4½ |
| Connections of transverse frames not water-tight to outside plating | 8 |
| Deck plating to beams, and in general where special strength is not required | 8 |
| Connections of floor plates, brackets, lightened intercostals, etc., to clips and angles | 7 |
| Connections of vertical keel angles where not water-tight, of angles and other stiffeners to bulkheads, of boiler and engine bearings, and foundations generally | 6 |
| Connections of inner-bottom plating to all nonwater-tight frames and longitudinals | 5 |
| Connections of angles of water-tight frames and longitudinals to all plating, and in general where water-tightness is required between plates and shapes | 4½ |
| Connections of armor-shelf angle to shelf and outside plating | 4½ |
| In special cases of intercostals, beam ends, etc., where strength is required in connections of limited extent, spacing to be as required by circumstances, except that the rivets in the same line should never be spaced less than | 3 |

Where the spacing in the above table cannot be followed exactly, as will generally be the case, the aim will be to make the spacing a trifle closer, as necessary, in the case of heavier plating, and a trifle further apart, as necessary, in the case of lighter plating, the division between "lighter" and "heavier" plating coming at about 7 1-2 lb. plates for single riveting, at about 15 lb. plates for double riveting, and at about 25 lb. plates for treble riveting.

Where the above distinctions are considered too complicated for yard work, the general rule will be to space a trifle closer, in all cases, as necessary for equal spacing.

When strength is required in laps and butted connections of plating, with the spacing indicated, single riveting is suitable only for plating under 12 1-2 lb. and double riveting for plating under 25 lb. Where strength is to be specially considered for the spacing of rivets in rows, the curves of exact spacings given on Sheet II (see page 13), should be consulted, or independent calculations made. For maximum strength in connections of platings above 30 lb. it will generally be found that quadruple riveting is required.

Single butt straps and edge strips should be 1 1-4 times the thickness of plates connected.

TABLE III.—BREADTH OF LAPS AND STRAPS.

| | Diameters. |
|---|---|
| Breadth of laps for single riveting | 3½ |
| Breadth of laps for double riveting | 5¾ |
| Breadth of laps for treble riveting | 8¼ |
| Breadth of treble-riveted butt laps in outside plating | 9¼ |
| Breadth of edge strip for single riveting | 6½ |
| Breadth of edge strip for double riveting | 11½ |
| Breadth of butt strap for double riveting | 11½ |
| Breadth of butt strap for treble riveting | 16½ |

TABLE IV.—ALLOWANCE IN LENGTH OF RIVETS FOR POINTS.

| Diameter of rivet | In. ¼ | In. ⅜ | In. ½ | In. ⅝ | In. ¾ | In. ⅞ | In. 1 | Ins. 1⅛ | Ins. 1¼ |
|---|---|---|---|---|---|---|---|---|---|
| | Allowance for point, over 2 thicknesses connected. | | | | | | | | |
| Type of point: | In. | In. | In. | In. | In. | In. | In. | In. | Ins. |
| Countersunk | 5/16 | 3/8 | 1/2 | 5/8 | 3/4 | 3/4 | 7/8 | 1 | 1 1/16 |
| Hammered | 3/8 | 7/16 | 1/2 | 5/8 | 3/4 | 7/8 | 7/8 | 1 | 1 1/16 |
| Button | ---- | ---- | 1/2 | 5/8 | 3/4 | 7/8 | 7/8 | ---- | ---- |

The allowances given above apply only to rivets which fit the holes neatly, as hereinbefore described.

TABLE V.—REDUCTION OF DIAMETERS TO INCHES.

| Diameter of rivet. | Number of diameters. | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1⅝ | 2½ | 3 | 3¼ | 3½ | 4 | 4½ | 5 | 5¾ | 6 | 7 | 8 | 8¼ | 9¼ | 11½ | 12½ | 16½ | 18½ |
| | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. | Inches. |
| ¼ inch | 3/8 | 5/8 | 3/4 | 13/16 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 7/16 | 1 1/2 | 1 3/4 | 2 | 2 1/16 | 2 5/16 | 2 7/8 | 3 1/8 | 4 1/8 | 4 5/8 |
| 5/16 inch | 1/2 | 3/4 | 15/16 | 1 | 1 1/16 | 1 1/4 | 1 3/8 | 1 9/16 | 1 13/16 | 1 7/8 | 2 3/16 | 2 1/2 | 2 9/16 | 2 7/8 | 3 9/16 | 3 7/8 | 5 1/8 | 5 3/4 |
| ⅜ inch | 5/8 | 15/16 | 1 1/8 | 1 3/16 | 1 5/16 | 1 1/2 | 1 11/16 | 1 7/8 | 2 1/8 | 2 1/4 | 2 5/8 | 3 | 3 1/16 | 3 7/16 | 4 5/8 | 4 11/16 | 6 3/16 | 6 15/16 |
| 7/16 inch | 11/16 | 1 1/16 | 1 5/16 | 1 7/16 | 1 1/2 | 1 3/4 | 2 | 2 3/16 | 2 1/2 | 2 5/8 | 3 3/16 | 3 1/2 | 3 5/8 | 4 1/16 | 5 | 5 7/16 | 7 3/16 | 8 1/16 |
| ½ inch | 13/16 | 1 1/4 | 1 1/2 | 1 5/8 | 1 3/4 | 2 | 2 1/4 | 2 1/2 | 2 7/8 | 3 | 3 1/2 | 4 | 4 1/8 | 4 5/8 | 5 3/4 | 6 1/4 | 8 1/4 | 9 1/4 |
| ¾ inch | 1 3/16 | 1 7/8 | 2 1/4 | 2 7/16 | 2 5/8 | 3 | 3 3/8 | 3 3/4 | 4 5/16 | 4 1/2 | 5 1/4 | 6 | 6 3/16 | 6 15/16 | 8 5/8 | 9 3/8 | 12 3/8 | 13 7/8 |
| ⅞ inch | 1 7/16 | 2 3/16 | 2 5/8 | 2 13/16 | 3 1/16 | 3 1/2 | 3 15/16 | 4 3/8 | 5 | 5 1/4 | 6 1/8 | 7 | 7 7/16 | 8 1/16 | 10 1/16 | 10 15/16 | 14 7/16 | 16 3/16 |
| 1 inch | 1 5/8 | 2 1/2 | 3 | 3 1/4 | 3 1/2 | 4 | 4 1/2 | 5 | 5 3/4 | 6 | 7 | 8 | 8 1/4 | 9 1/4 | 11 1/2 | 12 1/2 | 16 1/2 | 18 1/2 |
| 1⅛ inches | 1 13/16 | 2 13/16 | 3 3/8 | 3 5/8 | 3 15/16 | 4 1/2 | 5 1/16 | 5 5/8 | 6 7/16 | 6 3/4 | 7 7/8 | 9 | 9 1/4 | 10 3/8 | 12 15/16 | 14 1/16 | 18 9/16 | 20 13/16 |
| 1¼ inches | 2 | 3 1/8 | 3 3/4 | 4 1/16 | 4 3/8 | 5 | 5 5/8 | 6 1/4 | 7 3/16 | 7 1/2 | 8 3/4 | 10 | 10 5/16 | 11 9/16 | 14 3/8 | 15 5/8 | 20 5/8 | 23 1/8 |
| ⅛ inch | 1 | 1 1/16 | 1 1/16 | 2 | 2 3/16 | 2 1/8 | 2 13/16 | 3 1/8 | 3 3/8 | 3 1/4 | 4 1/8 | 5 | 5 3/16 | 5 13/16 | 7 3/16 | 7 13/16 | 10 5/16 | 11 9/16 |

Centers of rivets should be placed not less than 1 5-8 times the diameter from the edges. In double and treble riveting, the distance from center to center of rows should not be less than 2 1-2 diameters, and in butt laps of outside plating not less than 3 diameters.

Double butt straps should not be used for water tight work, owing to difficulty in calking. They may be used, however, to advantage in connections requiring great strength, but not water tightness. Where double butt straps are used, the size of rivet to be used will be as follows:

For plates from 15 to 20 lb., exclusive, 5/8 in. rivets.
For plates from 20 to 25 lb., inclusive, 3/4 in. rivets.
For plates above 25 lb., as per single riveted straps.

Centers of rivets should be 1 5-8 diameters from the edge and rows spaced 3 diameters from center to center.

Width of straps for double riveting, 12/4 diameters.
Width of straps for treble riveting, 18½ diameters.

Thickness of each strap to be 1-2 the thickness of plates connected for double riveted straps, and 5-8 the thickness for treble riveted straps.

Spacing of rivets in rows to be calculated, or taken from Sheet II (see page 13).

Special care will be taken in riveting that rivets used are of sufficient length to insure a proper point, the aim being to have the rivet a trifle long if anything. Such cutting as is necessary should be done while the rivet is still a dull red, and the point finished after further cooling. The allowances for length over the thicknesses connected are given in Table IV, the allowance being for two thicknesses only. An additional allowance of 1-16 in. is to be added to that given for each additional thickness connected, unless the additional thickness is less than 3-16 in., when 1-32 in. additional allowance will be made.

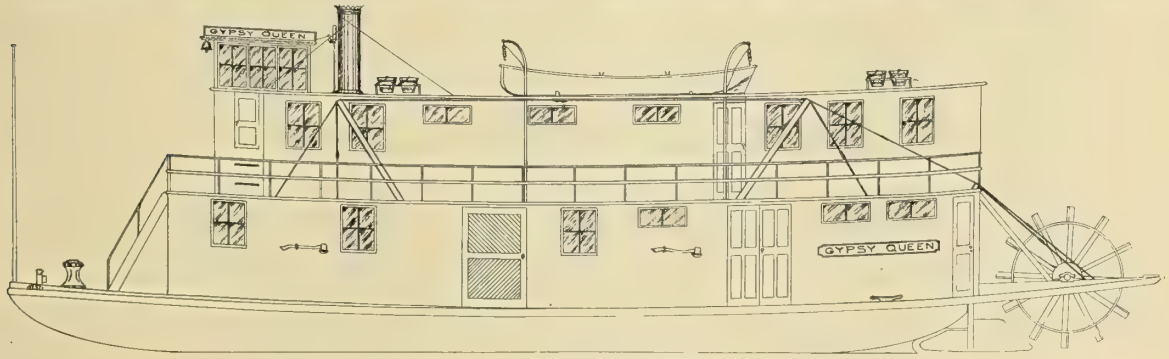
In all exceptional cases the spacing will be as directed by the Superintending Constructor. For special foundations, or where there is liability to excessive vibration or corrosion, the spacing as laid down in the foregoing rules will be departed from as he may deem advisable.

Table V is given for convenience in transposing a spacing or dimension, given in diameters, to its actual value in inches, to the nearest sixteenth covering all such values embodied in the foregoing rules.

**River Boat Gypsy Queen for the "Klondike."**

A typical river boat for the "Klondike" trade is shown in the sketch of the Gypsy Queen just completed by the Marine Iron Works of Chicago. This is a double cabin stern wheel boat with a wood hull, built in sections for convenient transportation to the Yukon gold fields. The principal dimensions are: Length on L. W. L., 60 ft.; beam on L. W. L., 16 ft.; width of guards, 2 ft.; width on deck, 20 ft.; length of lower cabin, 50 ft.; width of lower cabin, 16 ft.; upper cabin, 44 ft. by 12 ft.; pilot house, 6 ft. by 7 ft.; head room all through, 6 ft. 6 in. the clear; draft with 30 tons of load, 2 ft.

The hull is of white oak and Georgia pine, fastened almost entirely with bolts. To keep down weight even the boiler, which is of the water-tube type, is provided with a built up drum, the heaviest section of which weighs 400 pounds. In the machinery equipment, indeed, special care has been taken to have every part light and strong, having regard to the severity of the climate and the remoteness from any modernly equipped repair shop. Cast steel, bronze, and forgings have largely been used instead of cast iron. The paddle engines have cylinders 7 1-2 in. by 28 in. with balanced piston valves built for a steam pressure of 200 pounds per sq. in. The boiler has 19 sq. ft. grate surface and 600 sq. ft. heating surface. The stern wheel is 9 ft. dia. and 11 1-2 ft. wide, fitted with 12 buckets each 12 in. wide. It is counterbalanced to offset the weight of cranks and rods. There is also fitted an electric light plant, feeding fifty 16 C. P. incandescent lamps throughout the boat. The only fuel obtainable in the Yukon region at present is wood. Heretofore a plentiful supply of seasoned timber, which averaged 3,000 pounds to the cord, was obtainable, but this has been pretty much used up and next season green wood will probably have to be used, weighing 4,000 pounds to the cord. It is calculated that the Gypsy Queen when headed up stream will consume approximately four cords in 24 hours, and as she will average five miles an hour the consumption will be about one cord for thirty miles. Wood stoves are used for heating the cabins and there is also a hot water heating system as well as hot water supply in the bath room.



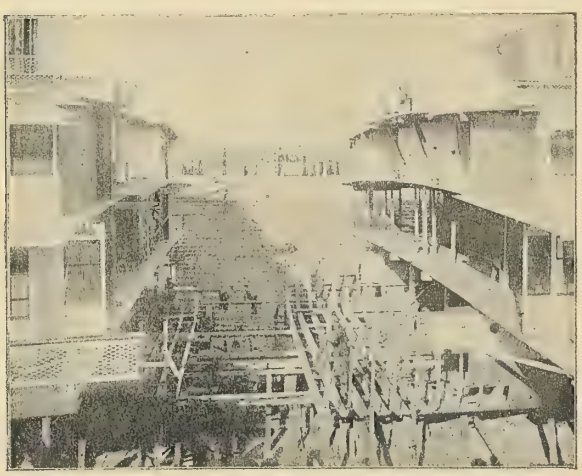

STERN WHEEL BOAT GYPSY QUEEN FOR YUKON RIVER.

### Lengthening the River Steamer New York.

Lengthening a steamship by cutting it in two and building in additional frames and plating has become a very frequent operation in shipbuilding practice.

A clever example at home of this operation is shown in the accompanying engraving of the Hudson river steamer New York, which has been lengthened 30 ft. by the Erie Basin Dry Dock Co., in Brooklyn. The vessel is one of the famous Albany Day Line boats and in dimensions is 311 ft. long, 40 ft. beam molded, and 12 ft. 3 in. deep. Her normal draft is 6 ft. She is a side wheel vessel, with feathering floats, and is fitted with a 3,800 H. P. beam engine and three return flue boilers.

The incision was made just abaft the funnels and forward of the engine. The New York was floated into the dry dock and let down on the blocks in the usual way. Then a cradle was built beneath the forward portion of the hull, and this was carried on regular launching ways, except that they had no inclination. When this was ready, the rivets in the plating were cut out and the bow section drawn forward along the ways



ENDS DRAWN APART, SHOWING NEW FRAMES.

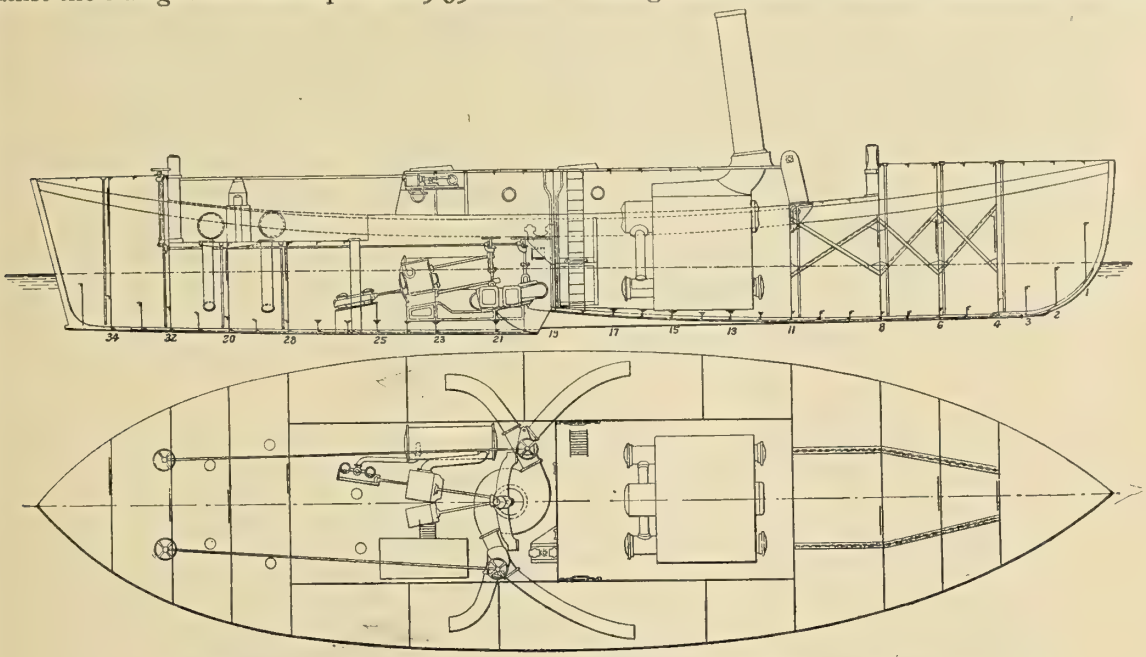
by tackle leading to steam winches in the yard, beyond the dock coping. The section moved weighed about 350 tons and was brought to its new position in five and a half minutes. When the two ends were lined up, the bow section had a vertical cant of 3-16 in. to port and there was a fore and aft twist of about 1 in. These were easily corrected and the work of raising the additional frames was rushed, so that within 17 1-2 hours from the time of docking the frames were up and ready for the platers. The addition to length brings the wheels considerably farther aft relative to the entire length of the boat. It is expected that her draft will be lightened several inches and a slight increase of speed will be possible with the same power. The arrangements were made under the supervision of W. D. Dickey, superintendent of the company. A similar operation was performed on her sister ship, the Albany, about five years ago.

### Hydraulic Propelled Steam Lifeboat.

Hydraulic propulsion has been tried both in this country and in England, and has been abandoned because of its low efficiency as compared with screw propulsion. There are cases, however, in which the special advantages of the system more than offset the wastefulness, and one of these is the equipment of a steam lifeboat. A screw propeller, in the ordinary form, could not be used for fear of mishap by fouling ropes or wreckage, and again the violent motion of the boat in short steep seas would cause unmanageable racing. For these reasons the Royal National Lifeboat Institution of the British Isles when planning a steam lifeboat recently decided to build a hydraulic propelled boat. The contract was let to John I. Thornycroft & Co., the well-known English torpedo-boat builders, and they constructed the boat here illustrated. She was named the "Queen," and is now stationed at Liverpool on the Mersey. A boat of this type had previously been built for the Dutch institution and proved very successful. The photographic reproduction shows the "Queen" steaming on the river Thames on a trial trip from the builders' works. She is built of mild steel and her dimensions are: Length, over all, 55 ft.; on the water line, 53 ft.; breadths, molded, 13 ft. 6 in.; over sponsons, 15 ft.; and extreme, 16 ft.; depth molded, 5 ft. 6 in.; extreme water draught, when fully loaded, 3 ft. 3 in. The load consisted of crew, four tons of coal, mast and sails, and several passengers, and the tanks full of fresh water, which, with the propelling machinery and boiler give her a displacement of about 30 tons. The hull of the boat is divided into eighteen watertight compartments, two of which are occupied by the engines and boiler, and two forming the coal bunkers, each being capable of being freed of water—the smaller by a portable deck pump, and the larger by the main engines.

The propelling machinery consists of a compound surface condensing engine, with cylinders side by side and inclined, 8 1-2 in. and 14 1-2 in. dia., and 12 in. stroke. This drives direct a nearly horizontal centrifugal pump, the impeller of which, 30 in. dia., delivers the water with which the pump is fed, by a scoop-shaped inlet amidships, through four nozzles or outlets in the sides of the boat, two for motion ahead—one on either side—being placed below the water, aft, and those for motion astern close under the sponsons above water, forward. The engine has no reversing gear, but is always running one way, the direction of the boat ahead or astern being controlled by valves in the discharge pipes from the centrifugal pump. These controlling valves can be worked either from the engine room or by the coxswain at the steering wheel, and by moving one valve only the boat may be made to turn round on her center, and may consequently be steered independently of the rudder. The boiler is of the ordinary Thornycroft water-tube type,

situated in a separate closed compartment forward of the engines and with a fan for forced draft. The steam pressure is 140 lbs. per sq. in. maintained with an air pressure in the stokehold, on a trial run, equal to 2 3-8 in. of water. The power developed by the engines was 220 I. H. P. at 449 revolutions per minute. Runs with and against the tide gave a mean speed of 9.39 knots.

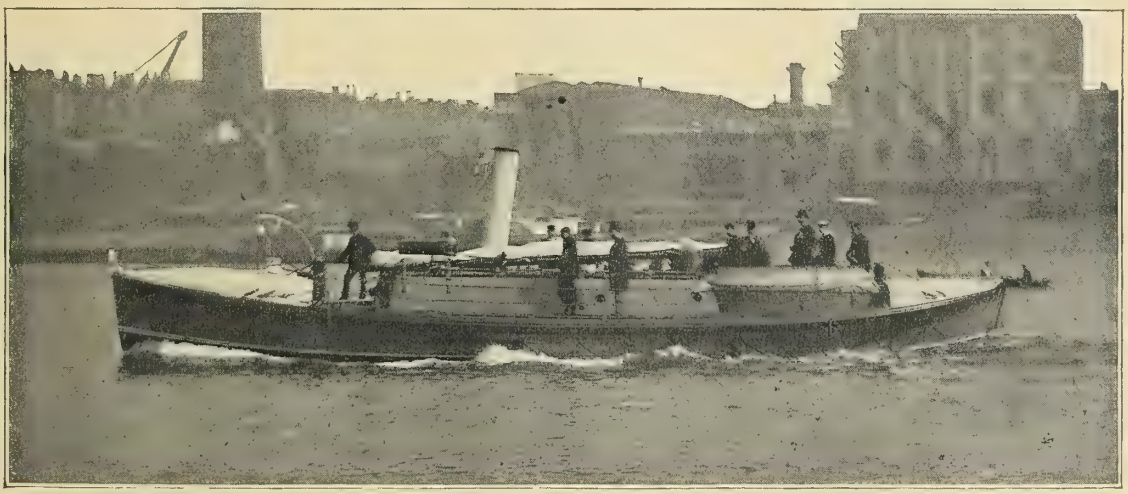


SKETCHES SHOWING LOCATION OF MACHINERY IN LIFEBOAT QUEEN.

Steering is effected by an ordinary deep rudder, which is moved by simple worm gearing and fitted with an arrangement for tricing it up in shoal water, without interfering with steering operations. For working the anchor and warping purposes a steam capstan, driven by an independent engine, is fitted at the after end of the engine-room, a reel of 100 fathoms of flexible steel wire rope being fixed in the cockpit or well of the boat. To assist the propelling power and the steadying of the boat it is fitted with a mast hinged in a tabernacle forward, and when not in use is lowered and stowed along the covering of the machinery. When in use it carries a lug sail and staysail.

The boat was placed on her station early last month after a rather severe test in the Mersey, during which Lord Charles Beresford, the Lord Mayor of Liverpool and other officials, remained on board. There was almost a gale blowing. The cost of this boat complete was $25,000, which was made up by donations from Liverpool merchants and marine organizations.

The general arrangement of the machinery is shown in the accompanying drawings, for which and the description of the boat we are indebted to the courtesy of Messrs. Thorp, Platt & Co., of New York, the builders' agents in America.



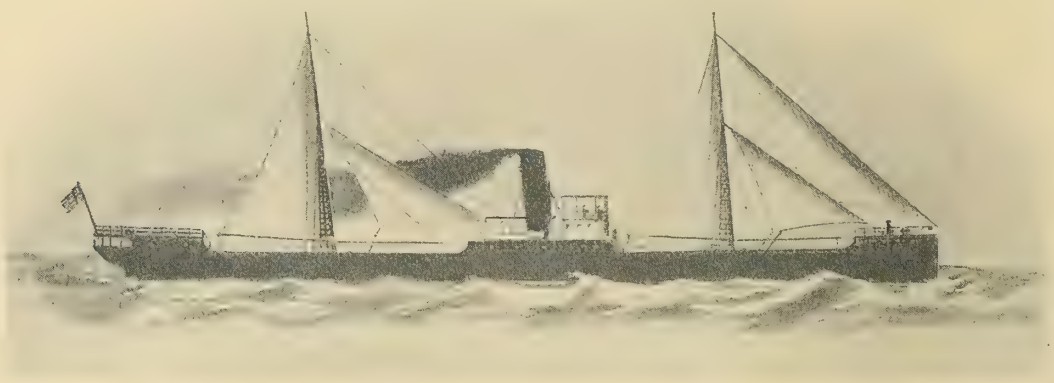
HYDRAULIC PROPELLED LIFEBOAT QUEEN STEAMING ON THE RIVER THAMES.

## FIRST AMERICAN STEEL TRAMP STEAMSHIP NOW BUILDING AT BATH, ME.

At the Bath Iron Works, Bath, Me., a steel steamer is now under construction which will occupy a very prominent place in the history of American shipping. This is the first steel tramp ocean steamer which is American clear through, in design, material, workmanship and ownership. On November 30 the contract was closed by the builders with Messrs. Miller, Bull & Knowlton, of New York, for whom the steamer is building. She will likely be called the "Winifred," after the latter gentleman's youngest daughter.

The new steamer has been designed with very great care and much skill to compete with any vessel of her class, afloat or building, of any nation. Her principal dimensions are: Length over all, about 305 ft.; between perpendiculars, 290 ft.; beam, extreme molded, 42 ft.; beam at main deck, 41 ft. 6 in.; depth molded at lowest point of sheer in center of deck, 25 ft. 8 in.; depth molded at side, 24 ft. 10 in.; load draft, 18 ft. 9 in.; free board, 6 ft. 1 in. As will be seen from these figures, the "Winifred" has a large percentage of reserve buoyancy, and if the minimum freeboard is designated by Lloyds, she will probably be allowed to load beyond this load draft. A general idea of the appearance of the steamer as she will sit in the water can be had from the accompanying engraving. She will be built to conform to Lloyds highest class, and the hull will be especially heavy and strong. The proportions according to Lloyds rules are: Ratio of length to depth, 11.18 to 1; length to beam, 6.87 to 1, and beam to depth, 1.62 to 1. The vessel has a very full midship section, the deadrise being about 12 in. and her block co-efficient is about eight-tenths. She is handsomely modeled, and her entrance and run, for a boat of this fulness, are remarkably easy and fine. She will be very thoroughly subdivided, having six complete water-tight transverse bulkheads and two partial bulkheads.

As will be noticed in the engraving, the "Winifred" will have a forecastle, bridge-house amidships and high poop. The bulwarks connecting the ends will be about 3 ft. high and will form a forward and after well. In the forecastle there will be berths for eight firemen and eight sailors with mess room, wash room and toilet room. Here there will be also carpenter shop, lamp room, vegetable store and ice room. A Hyde steam windlass will be located on the forecastle deck. The midship house as designed will be solely for the accommodation of the ship's officers. The machinery casings run fore and aft in the center, with a Williamson steering engine at the forward end and a commodious storeroom at the after end of the bridge. On the port side the design shows six comfortable staterooms, with necessary baths and toilet rooms, for the accommodation of the Chief and Assistant Engineers, First and Second Mates, Quartermaster and oilers. On the starboard side a large mess room occupies the forward end of the bridge, abaft of which is the galley, pantry and cold storage rooms, and at the after end on this side, the room for the Steward and cooks. The passageways through the bridge-house, connecting the forward and after decks, are 4 ft. wide.



STEEL TRAMP STEAMSHIP WINIFRED AS SHE WILL APPEAR AT SEA.

The poop is designed for the use of the Captain and passengers, there being three large spare staterooms here, with toilet room, pantry and a spacious saloon or cabin.

On the bridge deck forward, the chart house is placed, with the top extending to the sides forming a navigating bridge.

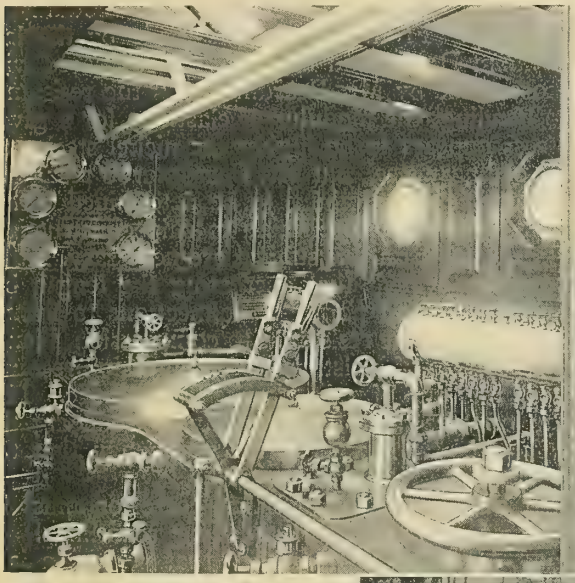
The steamer designs show a double bottom on the McIntyre system, the depth of the tank being 4 ft. This will contain about 700 tons of water ballast. The tank top is ceiled with 2 1-2 in. yellow pine. Yellow pine 3 1-2 in. thick is also used to cover the lower deck, and 2 in. thick for the forecastle, bridge and poop decks. The main deck is of steel throughout and is only covered with 2 1-2 in. yellow pine in the living spaces.

Arrangements for handling cargo are very carefully worked out. Large hatches are fitted, those on the main deck (of which there are four)

are each 26 ft. long and 14 ft. wide. On the lower deck they are the same length, but 2 ft. wider. The bulwarks are arranged to be hinged in the wake of the masts to facilitate loading and unloading. There are two pole masts, each mast

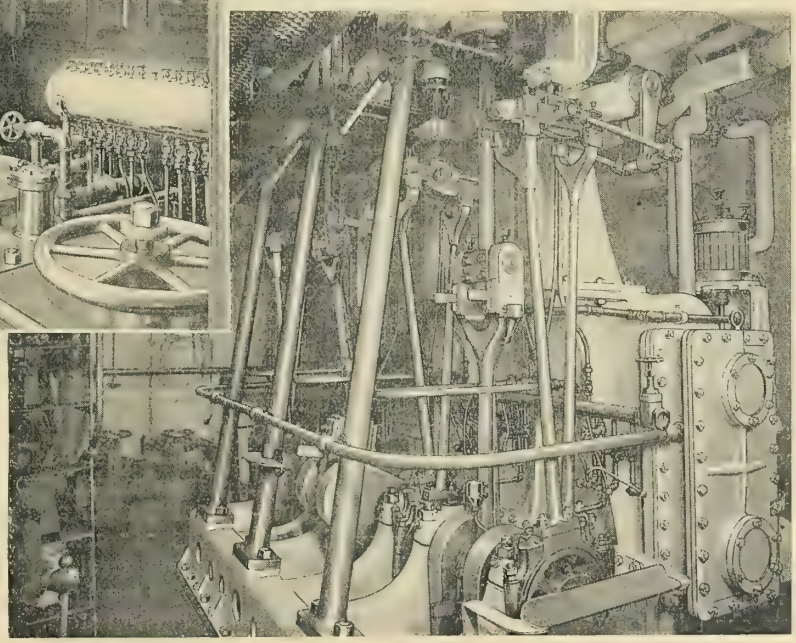
U. S. REVENUE STEAMER GOLDEN GATE, IN SAN FRANCISCO HARBOR.

to be fitted with four 40 ft. cargo booms and special chain stays for the rapid handling of light cargo. The vessel will be provided with leg of mutton sails, one of the cargo booms on each



mast being used as a boom for the foot of the sail when canvas is spread. Two large life boats and an 18 ft. gig will be carried on the bridge deck.

The machinery will consist of a triple-expansion engine of about 1,200 I. H. P., with cylinders 20 1-2 in., 34 in. and 55 in. dia. and 3 ft. stroke, run at about 95 revolutions. Steam will be furnished at a pressure of 165 pounds by two Scotch boilers, each 12 ft. 6 in. dia. and 12 ft. 3 in. long. The grate surface is 120 sq. ft. and heating surface about 4,000 sq. ft. A Scotch donkey boiler about 7 ft. 6 in. dia. will furnish steam for the windlass, steering engine, and four large cargo winches. Coal bunker capacity for 450 tons is provided in such a way that part of the bunkers will be available for cargo on short voyages. The "Winifred" will have capacity for about 178,000 cu. ft. of grain and about 170,000 cu. ft. of bales. It is estimated that she will carry about 3,700 tons dead weight on 18 ft. 9 in. draft at a speed of about 10 knots.



VIEWS IN ENGINE ROOM OF STEAMER GOLDEN GATE.

### U. S. Revenue Steamer Golden Gate.

The Golden Gate was designed as a boarding-boat for use by the Custom House authorities in San Francisco Harbor, California, and was recently built complete by Moran Bros. Company, Seattle, Wash. The hull is constructed entirely of open-hearth steel, and the principal dimensions are: Length over all, exclusive of fenders, 110 ft.; length between perpendiculars, 100 ft.; breadth of beam moulded, 20 ft., 6 in.; depth moulded at mid-length, between perpendiculars, 12 1-2 ft.

The vessel is fitted with a main deck house constructed of steel and a pilot house on top, the interior finish being in native hard woods, maple and spruce. She is fitted with a Williamson steam steering engine. The vessel is propelled by a vertical engine of the triple expansion type, with H. P. cylinder 13 in. dia., I. P. cylinder 21 in. dia., and L. P. cylinder 32 1-4 in. dia., and a stroke of 24 in. The collective I. H. P. of the propelling, air pump, and circulating pump engines is 525 when the main engine is making 160 revolutions per minute. The condenser forms part of the main framing of the engine. The air and circulating pump is of the Blake vertical patent, and is attached to the condenser and operated independently from the main engine. The propeller is of manganese bronze, right-handed, true screw, with four blades 7 ft., 6 in. dia. and 10 ft., 6 in. pitch. The condenser is fitted with 592 seamless drawn brass tubes 5-8 in. O. D., No. 18, B. W. G., and they are 8 ft. 3 1-4 in. long. The vessel made on her trial run a speed of about 14 knots.

The boiler is of the Ward water-tube, with 77 sq. ft. grate surface and 2,970 sq. ft. heating surface. The boiler casing is 11 ft. 6 in. dia. and 8 ft. 3 in. high. There is bunker capacity for 50 tons, and the fresh water tanks hold 3,000 gallons.

## ON NICKEL STEEL AND ALUMINIUM AS MATERIALS FOR SHIP CONSTRUCTION.*—II.

BY J. H, BILES, M.I.C.E.

In nickel steel of 52 tons ultimate and 28 tons elastic strength, as compared with ordinary steel of 28 tons ultimate and 14 tons elastic, a material is afforded which may be considered twice as strong as the mild steel at present in use. This would allow a reduction of one-half in scantlings which are determined wholly by tensional stresses if the butt connections can be made good. The unavoidably weakest section in the longitudinal plating of a ship is the line across the frames or beams, and where rivets in these lines are spaced eight diameters apart the strength is about seven-eighths (0.875) of the solid plate. Hence the question is: Can butt connections having 0.875 efficiency be developed? This is the highest possible strength of the plating. Taking the butt of only one plate into consideration, and neglecting the advantage of rivets in the landings between frame line and the butt, it is evident that if the back row has rivets spaced eight diameters apart, if sufficient rivet area be given, even if the rivet material is specifically only as strong as mild steel, if sufficient thickness of butt strap be given, we can make a riveted butt connection whose efficiency shall be 0.875. But the butt connection has not alone to be relied upon, as the adjacent passing strakes will give support to the butt. Hence there appears to be no great difficulty in developing sufficient rivet connection in the butts. It should be borne in mind that in passing from iron to mild steel the same difficulty had to be encountered. Iron rivets have as much strength per unit area as the plate. Steel rivets have not more than 80 per cent, nickel steel rivets have about 70 per cent. As to the landings or laps, there is not the same necessity for high efficiency. In the vicinity of the neutral axis, where the shearing stresses may be high, the same area of rivets as is now adopted will be more than sufficient.

As to the ratio of diameter of rivet to thickness of plate which the consideration of the bearing pressure imposes, it is easy to see that with 42 tons to 43 tons as limit of bearing pressure, and 22 tons as the effective ultimate resistance to shearing of rivets in groups, that the diameter of rivets should not exceed two and one-half times the thickness of plate. This is not in opposition to existing practice.

The question of resistance to compression is the vital one in adoption of nickel steel. The ultimate resistance to compression given by Mr. Beardmore in a specimen of 1.596 in. diameter and 10 in. long is 29.79 tons. But for thin plates the real resistance depends on the modulus of elasticity. From experiments made by the late William Denny and Mr. Martell, compared with those made by Mr. Beardmore, on the resistance to bending, the modulus of elasticity for a given stress appears to be higher for nickel steel than for ordinary steel, but Mr. Beardmore's results do not enable the modulus to be determined within limits which are applicable to ship construction. Experiments on this subject are necessary. It is, however, evident that decreasing the length between the fixed points or connections to frames will increase the resistance to compression. Hence the problem of resistance to compression resolves itself into one of reducing the frame space. This can only be done economically by reducing the weight of the frames in the proportion that the frame space is reduced.

It may be anticipated that corrosion must be taken into account in reducing scantlings. It may, however, be remarked that corrosion is a function of two things: (1) The specific resistance to corrosion of the material; and (2) the care that is taken of the material to protect it from corrosive action.

The first has been experimented upon by Mr. Beardmore, who gives the relative corrosion of nickel steel and mild steel as 1.36 per cent and 1.72 per cent, a gain of 21 per cent in favor of nickel steel. Mr. Riley gives the corrosion of nickel steel of 3 to 5 per cent of nickel, as one-half of carbon steel.

The second consideration can only be referred to experience. When a ship corrodes badly, it is due to neglect. It is possible to take sufficient care of ships that practically no corrosion takes place. Well cared for war ships have practically

* From a paper read before the Institution of Civil Engineers, London, 1896.

no corrosion. In torpedo boats with very thin scantlings, galvanizing and proper care avoid the results of corrosion. In a torpedo vessel built in 1885, which has recently been opened up for reboilering, it was found that the hull was practically as good as new. Hence any objection, on account of corrosion, to reducing scantlings may be discounted, by insisting upon proper precautions being taken in the care of the vessel.

The possibilities of adding resistance to compression are not exhausted by reducing frame space. Additional rigidity may be given to the plating by arranging its sectional area, so that the plates are narrower, and consequently have more landings or laps to stiffen the plating. Further, the edges of the plates may be stiffened by flanging them between the frames. The subject is one deserving of experiment.

Many local requirements of strength in a ship are determined by rigidity, and not ultimate strength; but in a great many of these there is unfortunately no precise method of procedure. In passing from iron to mild steel many of these cases followed the general rule of 20 per cent reduction, and no ill effects have followed. Mr. Martell, in his report in 1877, upon which the action of Lloyd's in reducing scantlings in ships built of mild steel was based, stated that a 5-16 in. steel plate would resist deflection as well as a 6-16 in. iron one. The difference in tensional strength between nickel steel and mild carbon steel is greater than that between mild steel and iron. Experiment could readily determine whether the stiffness of nickel steel is proportionately greater than that of mild steel.

The reduction of specific weight of material seems to be only possible by the adoption of aluminium. It seems doubtful whether any alloy of this metal of small specific weight has been produced which can successfully resist the action of sea water. There are, however, many parts of a ship where sea water has little chance of doing damage. Between deck-beams, pillars, plating of bulkheads, etc., also deck-houses in light-weather ships, are fairly clear from this corrosive action.

Taking mild steel at three times the specific weight of aluminium, it would, for strength, be preferable to adopt the latter metal in many cases even at one-half of the ultimate strength. Even if its thickness were twice that of mild steel, it would be more rigid, while it would be one-third lighter. Mr. Yarrow, in his paper on aluminium torpedo boats, gave the tensile strength of aluminium alloyed with 6 per cent of copper as 14 tons to 16 tons.

It may be interesting now to see what effect upon the design of a 10,000-ton ship the adoption of nickel steel would have. It may be assumed that nickel steel, 50 per cent stronger than mild steel, can be produced with certainty. The relative weight of parts subjected to longitudinal stress may be reduced 33 1-3 per cent. If we assume that to resist compressive strains we have to reduce frame spacing, and can only take advantage of the increased strength of the material to the extent of one-half, we shall only gain 16 2-3 per cent in transverse framing material. The total gain in a 10,000-ton ship will be 1,000 tons on a weight of 6,000 tons—this is 16 2-3 per cent. It was found in passing from iron to mild steel that from 1 1-4 to 3 1-2 per cent was added by increased weight of butt straps, laps, etc., and though a smaller percentage would probably be added in this case, some allowance should be made. It seems as if from 14 per cent to 15 per cent of the weight of steel could be saved. This reduction in the weight of hull can be used to increase weight of machinery and coal. The extra speed resulting therefrom in a 20-knot ship will be 1 1-4 knot with an extra total coal consumption of 13 per cent. To produce a mild steel vessel carrying the same dead weight of cargo, and having 21 1-4 knots speed, the dimensions would have to be increased by 10 per cent, the horse power by 40 per cent, the first cost by 20 per cent, say $350,000, (supposing passenger accommodation to remain the same). Supposing the cost of workmanship is the same in a nickel steel vessel of the same dimensions as in one of mild steel (it will probably be less), we should have as the only difference in first cost of the two vessels that between 6,000 tons of mild steel and 5,000 tons of nickel steel. The former might cost $200,000, but the latter could hardly cost $200,000 plus $350,000=$550,000, and anything below this would be in favor of the nickel steel ship, both in economy of first cost and in economy of upkeep. The coal bill in the mild steel ship would be 19 1-2 per cent more than in the nickel steel ship. The 5,000 tons of nickel steel could probably be bought at present for $375,000, leaving a balance of $175,000 of saving.

These figures are given to show the great value which increase of strength of material has upon the design of a ship and upon its first cost. In other types of ships savings in weight and engine power could be effected. In the low powered ships the gain would be less. Take the case of a 14 knot Atlantic liner of about 7,000 tons in addition to coal to do her voyage. She could carry 10 per cent, say 700 tons, more cargo if built of nickel steel. A mild steel vessel large enough to carry this extra cargo and maintain the same speed would cost $50,000 more. This, added to the cost of the mild steel in the vessel carrying 7,000 tons, would give a sum which would enable the builder to pay $45 per ton for the nickel steel. The extra cost at $75 per ton would be about 15 per cent of the first cost of the vessel. As there would be only 5 per cent less of coal and machinery expenses paid out to repay the extra first cost, it is doubtful whether, at $75 per ton in a vessel of this size, it would pay to build in nickel steel. It will be of interest to know what chance there is of this material being produced much more cheaply. No reference has been made to reductions in weight of machinery due to the adoption of nickel steel and their effect upon design.

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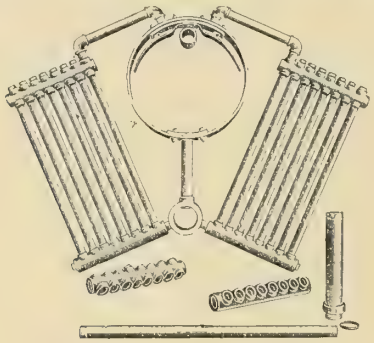
## IMPROVED APPARATUS.

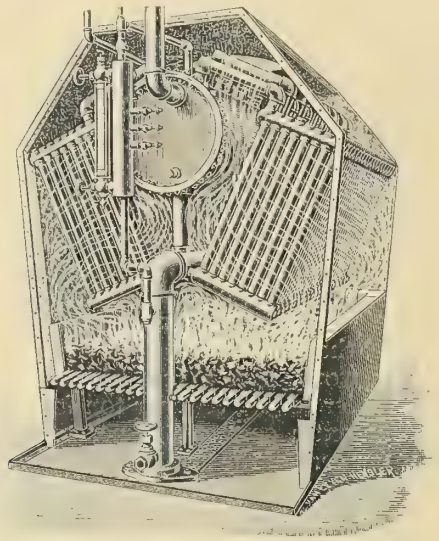
### The "Detroit" Water Tube Boiler.

The "Detroit" water-tube boiler consists of one large upper drum, connected for its entire length to the water distributing pipe, below and parallel



DRUM AND CONNECTIONS.

with it, by means of one row of vertical pipes for down flow of water. In either side of the water distributor the lower tube manifolds are screwed in, and from these the tubes proper continue to the upper manifolds, which are connected to the top part of the drum with right-and-left nipples. The tubes are inserted through the upper manifolds with right hand threads, the top end of the tubes being so enlarged that both ends engage at the same time. To each end of the water distributor there is attached a sediment pocket, extending to the floor. To this is attached a foot or flange for supporting and fastening the boiler, which is also supported at the sides by the casing, the latter being fastened to the plugs in the upper



"DETROIT" BOILER WITH CASING REMOVED.

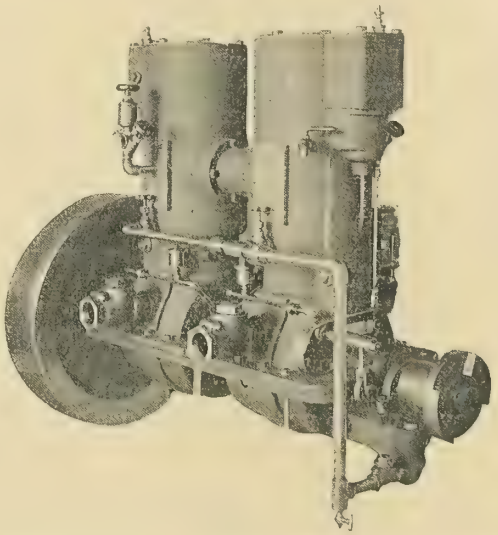
manifolds. The manifolds are placed so close together that the flame has to pass first to the outside, thence toward the center, thus causing an upward circulation in the outer row of tubes, these being exposed to the hottest fire, and a downward in those nearest the drum, hence the steam is partially separated from the water in the upper manifolds before it enters the drum, which is fitted with baffle-plates and dry-pipe. The boiler is the invention of H. H. Taylor, and is manufactured by the Detroit Screw Works, 49 Riopelle St., Detroit, Mich.

### Truscott Two-Cylinder "Vapor" Engine.

The illustration herewith shows a two-cylinder Truscott "vapor" motor ready for installation in a launch or motor boat. The construction is such that the engine can be set far back in the boat, thus giving more room for passengers. The working parts are cased in, as when running, the motion of the crank is used to assist in mixing the charge of gasoline vapor and air preparatory to its entrance into the cylinder above the piston. The motion is always in one direction, and consequently a reversing propeller is used, operated by a convenient lever inboard. In boats fitted with this motor the supply of gasoline is carried in a tank in the bow and is piped aft in the form of vapor, produced in a special apparatus. Materials and workmanship are guaranteed by the builders, the Truscott Boat Manufacturing Co., St. Joseph, Mich.

### Lee Oil Distributing Projectile.

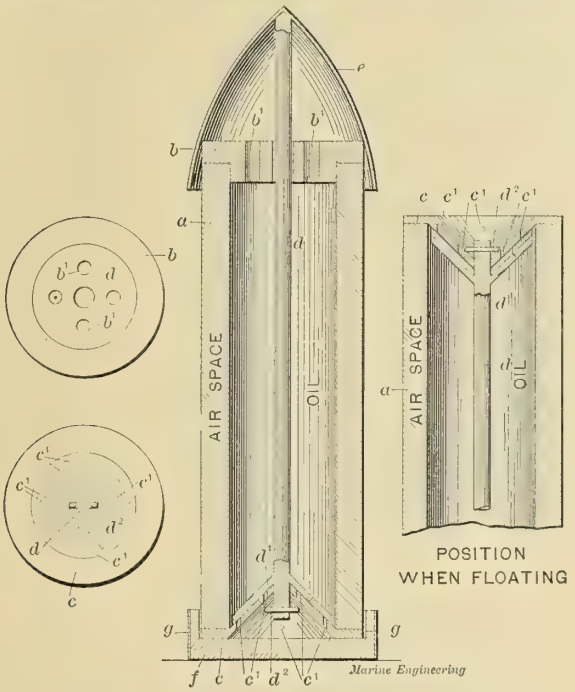
The Lee oil distributing projectile is intended to throw oil to windward in heavy weather for the purpose of quieting the waves. It is made to fit a Lyle gun and can be used on any vessel carrying such a gun of standard bore. For vessels laid to, light-ships at anchor, and in cases of rescue when boats must be lowered, it should



TRUSCOTT TWO-CYLINDER "VAPOR" ENGINE.

be very valuable. The projectile is made of tin tubes, one inside the other, with an air space between to give it buoyancy. A conical head is provided for the forward end and to this head a rod is attached which passes through the pro-

jectile to the other end, where a simple conical valve covers a valve seat with small holes in it. The forward end is made the heavier by a piece of metal, also with holes through it, and this weight is intended to keep the end forward during flight and also to make the projectile float in a perpendicular position after it has been thrown

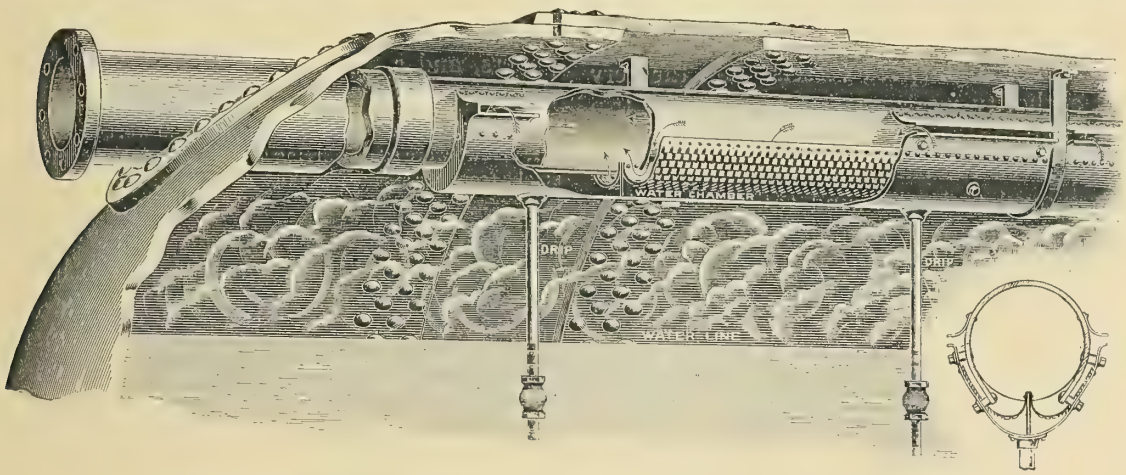



LEE OIL DISTRIBUTING PROJECTILE.

from the gun and fallen into the water. After filling with suitable oil, the projectile is placed in the gun, sufficient powder being used to throw it the distance required. After making its flight the projectile plunges into the water, but rises at once to the surface and floats head downwards. The conical head with rod falls by its own weight, opening the valve at what is now the upper end. The water now enters through the holes in the lower end and displaces the oil which passes out of the holes in the upper end and the oil is spread upon the sea and carried to leeward making rollers of the breaking waves. The aim has been to make a cheap but effective device. The cap on the end, shown in the cut, is to receive the impulse of the powder and falls off on leaving the gun. The inverted cut shows the position when floating and the valve open for passage of oil. The projectile was designed and patented by William W. Lee, of Northampton, Mass.

### Separator and Dry Pipe Combined.

We show herewith engravings of a new separator designed especially for marine boilers. It consists in the main of the combination of separating device in connection with a dry pipe. Instead of steam entering through holes on top or bottom of the dry pipe the steam enters through a narrow slit at a point about midway along each side. These slits are protected by an out turned lip both above and below, so that water splashed up from below or dashed down by striking the shell above, is thrown away from the slit, and however much the water may be thrown about, but very little can enter at any one time, and to capture and remove that little the following provision is made: After the steam enters the inlet it is forced to pass between two walls which are only just far enough apart to give ample passage, and the lower side of this passage is covered by a sieve. This sieve is made of perforated sheet metal, and in a sort of rat-trap way so that water can be passed through it but cannot be picked up again by the steam. The steam robbed of its water enters the dry pipe and so passes out while the water collects in the lower chamber, passes down through drain pipes and check valves into the water below. The water chamber is divided by a partition to prevent the water which is gathered on one side from going over and through the sieve on the other. This separator is being put on the market by the Direct Separator Company, of Syracuse, N. Y.




COMBINED DRY PIPE AND SEPARATOR FITTED IN MARINE BOILER.

# MARINE ENGINEERING

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WHAT'S the matter with the much boasted superiority of British engineering and ship building skill? The conventional reply can hardly be made, at this time, with accuracy. Not long ago the English technical papers had long accounts of the "largest" side wheel steamer afloat, viz., the "Empress Queen." She was truly a wonderful craft according to the modest London editors. From advices which we have received from her home port she is indeed a wonderful failure. This vessel, which was illustrated and described in our issue of June last, was built for fast passenger traffic between Liverpool and Douglas, Isle of Man, a route which has long been noted for high-speed vessels. On the very highest authority we learn that on her trial trip the most extraordinary precautions were taken to get speed, even the canvas on the flying bridge being removed to lessen wind resistance. She succeeded in doing 23.5 knots, but was nearly shaken to pieces in the attempt, and had to go back to the builders' yard to be strengthened. After she came out 22 knots was the best performance. In running at sea she is so down by the head that the forward promenade decks cannot be used by the passengers, unless they desire a continuous shower bath. And although run at enormous expense we learn that her best performance between Liverpool and Douglas is only two minutes better than that of the "Queen Victoria," a seven-year-old boat. While this is in mind a despatch from Valparaiso says that a torpedo-boat destroyer built in England for the Chilian Government was found to be so defective in construction as to be absolutely worthless. Then reports from across the sea tell of the unseaworthiness of the ferryboat Chebucto, built in Scotland to ply between Halifax and Dartmouth, Nova Scotia. The first time she started west across the Atlantic she had to put back because the crew refused to proceed. A lot of metal was worked into her in the builder's yard, and on her second attempt she was obliged to put into the Azores, damaged and leaking. There she will remain until some fine day in the spring, when, if the water is not too rough, she may reach Halifax and not the bed of the ocean. About this time, too, comes a report from Havana stating that the big floating dock built in England for the Spanish Government has got tired of floating, after her long tow across the Atlantic, and is now resting contentedly on the bottom. Add to all this the engineers' strike and the transatlantic records under the German flag and it would appear Britain has troubles of her own.

EVERY little while the daily papers, of this city at least, give much space, with hysterical head lines, to the narration of a "race" between Cunard and American liners. These descriptions invariably commence with an account of the sighting of one steamship by the other, and the subsequent efforts of the one to overhaul the other. The vessels are invariably described as giving forth immense volumes of smoke from their funnels. A recent brush between the St. Paul and Campania was so described in several papers, and a quotation from one will serve for the others:

> The engineers and firemen of the St. Paul worked with a will. The screws were sent whirring around faster than ever, and the smoke from her stacks was thick as it trailed in the wind behind the steamer.

Sometimes these descriptions are accompanied by fanciful sketches, showing an inky black trail following the liner. But science and the poetic spirit do not agree, and so far as the American liners are concerned the smoke exists only in the mind of the reporter. These boats happen to be equipped with the Howden draft and an almost perfect combustion is the result. They do not smoke for the very good reason that no smoke is manufactured in the process of converting coal into horse power. If the Chief Engineer of the St. Paul wanted to make things lively aboard the Campania, he would take precious good care that the heat value of his coal

did not pass out of the smoke pipes in the form of unconsumed carbon. Heavier firing would be accompanied by a speeding up of the induced draft fans, and the process of combustion would be just as perfectly carried out as though the ship were under slow speed approaching her dock. A slight brown haze might be occasionally observable drifting aft from the funnels, but it is a safe bet to make that a vessel clouding the horizon with smoke is not an American liner.

A CONTRACT was recently closed by the Bath Iron Works, Bath, Me., for a steel steamer the construction of which marks a very bright page in the history of American shipping. This is the first steel tramp steamer, designed by Americans, built by Americans, of American material and to sail under the American flag. While others have talked of ways and means of restoring the prestige of this nation as a freight carrier for the world at large, it has remained for a New York firm to take positive action in placing the order for this vessel. It is a pleasure to place on record the name of this patriotic firm, Messrs. Miller, Bull & Knowlton, of New York, by whose enterprise and good judgment the first step toward restoring to its rightful place the American merchant flag afloat has been taken. The construction of this vessel is consequently of intense interest to all who hope for the upbuilding and development of the merchant marine. In all lines of mechanical work America is making immense advances and corresponding inroads on the trade of other nations. Shipping has been neglected hitherto, but there are now very hopeful indications of an awakening. Abroad the tramp steamer has received the attention of the ablest naval architects and engineers, and a form of vessel has been evolved which is comparatively cheap to construct and maintain, and is perfectly seaworthy and economical. In designing the new vessel the Bath Iron Works has apparently not only availed itself of these experiences, but with native ingenuity has added many conveniences and useful modifications. It is of interest to note here that A. Sewell & Co., of Bath, have begun work on a new sailing vessel to be added to their well known fleet. This will also be built of steel, made in this country to the specifications of American ship builders. The firm already owns the large steel ship Dirigo, which, it will be remembered, was constructed here out of material shipped from England.

IN a recent issue we published an article by Prof. Durand, on the experimental tank, in which the author, referring to the long continued use of the tanks in existence, wrote:

> There is, in fact, on file in the archives of these various establishments an amount of data which, if massed together, properly analyzed and reduced to common standards of measurement, would render unnecessary a vast amount of work which is currently carried on in the various places individually. The causes of this duplication are commercial and well known.

This covers the ground very exactly, giving a statement of conditions and the reason therefor. But the statement is not only applicable to the design of vessels, but to a much greater extent to their operation. How many full powered vessels are there, for example, in daily service, compared with the number of tanks in use? and each of these vessels is more or less an experimental station. The superintending engineer of a line is as watchful of cause and effect as is the chief constructor of any yard. But for "commercial" reasons he is dumb outside the precincts of his company's office. Of course, the company which employs him benefits largely from the experiences which come under his observation, and from which he draws conclusions for changes in practice. How much greater would the benefits be to the profession at large were the experiences of each line, or indeed each vessel, properly reduced to a common basis of observation and made public? Take the case of transatlantic liners for example. Each trip across the ocean is a trial trip—one prolonged test. Not a trial trip of the vessel as a whole, perhaps, but of some new piece of apparatus or method of practice, which is thus put through the most severe and accurate of all tests—practical use. Every pound of coal consumed, or pound of water evaporated, every gallon of oil or quantity of other stores, is accounted for. Pressures and temperatures are noted and recorded. There is nothing left to guess work. Thus data of an immensely valuable sort is accumulated. Exact conclusions can be reached, not by mathematical processes or laboratory determinations, but by the actual working of the ship under service conditions. "Commerce" steps in, however, and blocks the way of science. Such results have only been secured by the expenditure of large sums, which figure in the operating expenses account, and consequently belong to the stockholders. So the unformed experiences of one company, which may be just what are needed to perfect a process unsuccessfully undertaken by another company, go for naught.

# CORRESPONDENCE.

*[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced if necessary to illustrate the subject, without cost to the writer.*

*Full names and addresses should be given, but publication of these will be withheld where requested.*

*We do not assume responsibility for the opinions expressed by correspondents.]*

### Replies to Walschaert Valve Gear Inquiry.

In answer to the inquiry concerning the Walschaert gear, given in the November number of your journal, I will give both the valve-ellipse and the polar diagrams for such a gear, as applied to a locomotive on the Revere Beach and Lynn R. R. Fig. 1 gives a diagrammatic representation of the gear, where A is the center of the driver axle, B is the center of the crank-pin and C is the center of the wrist-pin. D is a point on the cross-head which is connected by a rod D E to the combining-lever E G, G being a point of the valve-spindle, which is guided on a horizontal line. The point H is on the end of a return-crank so placed as to make the line A H at right angles to the crank A B; the point H corresponds to the center of an eccentric with no angular advance, and such an eccentric can be used instead of a return crank when that is more convenient. H gives motion to the curved and slotted rocking-lever J L, which is pivoted at L. The block K on the radius-rod F K may be placed at any place in the curved slot by means of the reversing mechanism R P N. The radius rod imparts motion to the point F of the combining-lever, so that the valve derives part of its motion from the cross-head and part from the point H. The motion from the cross-head is reversed by the combining-lever, so that it is equivalent to the motion from an eccentric with 90° angular advance, while the motion from H is equivalent to that from an eccentric with no angular advance. The resultant motion of the valve, obtained by combining the motion from these two sources, is equivalent to that of a shifting eccentric or a link motion, and is therefore proper for the reversing and expansion valve-gear of a locomotive. When the block K is at L, the motion of the valve is derived solely from the cross-head of the engine, and the maximum valve displacement is equal to the lap plus the lead. This valve displacement occurs at the dead point just as for a valve controlled by the mid-gear grade of a link motion. The radius rod F K is equal in length to the radius of the slotted-lever, consequently as that lever is erect when the engine is at a dead-point (which follows from the fact that H A B is a right angle) the block may then pass from end to end of the slot without moving the

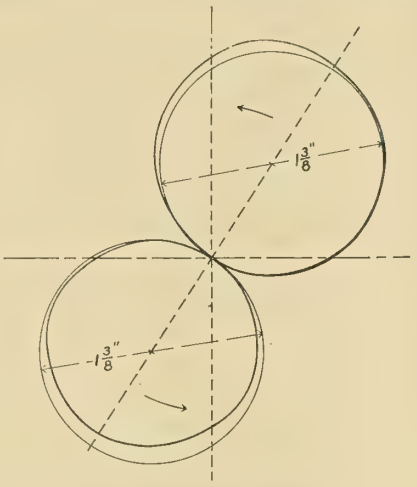


FIG. 3.—POLAR DIAGRAM.

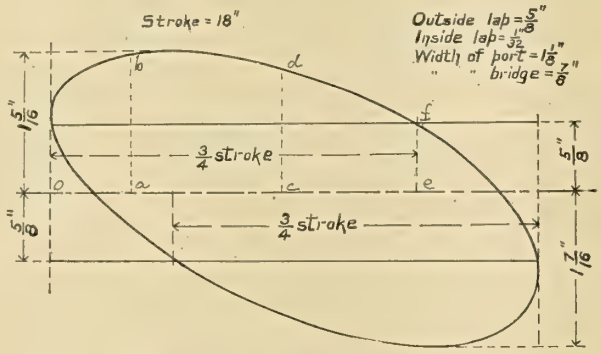


FIG. 2.—VALVE ELLIPSE.

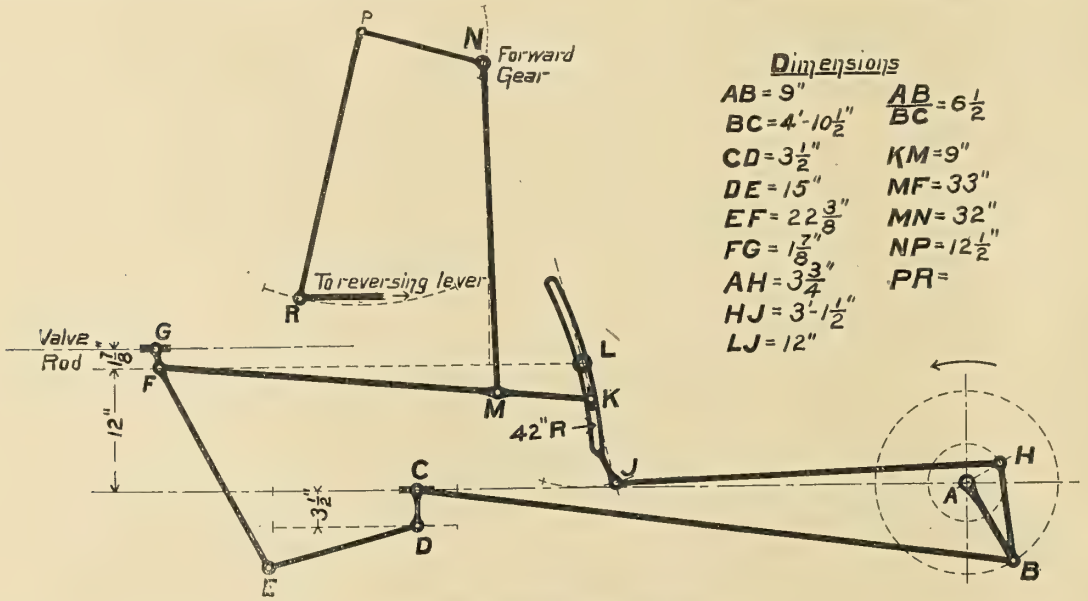


FIG. 1.—WALSCHAERT VALVE GEAR.

valve; that is, the lead for this gear, as for all radial valve-gears, is constant. When the block is placed at some other point than L, for example at K, the valve has a motion which gives a proper distribution of steam for the forward motion of the engine, as represented by the arrow, the point of cut-off depending on the proportions of the gear and on the distance K L of the block from the pivot L. If the block is raised above L the engine will be reversed. The only way of studying the motion of a valve controlled by the Walschaert gear, or by any radial valve gear, is to draw a diagram like Fig. 1 with successive positions of the cross-head and find the corresponding positions of the valve; or a carefully made wooden model may be used for the same purpose. Fig. 2 is a valve ellipse representing the motions of the piston and valve for the gear shown by Fig. 1. For several piston positions, measured from the beginning of the stroke, such as o a and o c, the corresponding valve displacements from mid-position, a b and c d are obtained as just described; and these valve displacements are set up as ordinates. A smooth oval curve drawn through b, d and similar points enables us to find at once the valve displacement for any piston position. Conversely we may find the piston position corresponding to any valve displacement. For example, a line drawn at a distance of five-eighths of an inch (the outside lap of the valve, from the axis, cuts the oval at f and shows that the cut-off occurs at three-fourths of the stroke. A similar construction shows that the cut-off occurs at three-fourths stroke for the return stroke also. The valve-ellipse drawn is for a late cut-off, nearly full gear. Similar ellipses for earlier grades of cut-off are likely in this case to show some inequality of cut-off. But as the valve gets part of its motion from the cross-head of the engine, equalization of cut-off is comparatively easy. The maximum valve displacement is somewhat unequal, being in this case 1 5-16 in. for the forward stroke and 1 7-16 in. for the return stroke. In Fig. 3 the valve displacements corresponding to various crank angles are laid off along the center line of the crank so as to give polar diagrams similar to Zeuner valve circles. The diagrams thus obtained are irregular ovals, which, however, do not differ very widely from circles having the diameter of 1 3-8 in., as shown on the diagram. The diagram for the forward stroke is below, and represents the displacements of the valve while the crank is below the center of the driver axle; the upper diagram represents the displacements of the valve for the return stroke while the crank is above the axle. The curved and slotted rocker has a general resemblance to the link of a Stephenson link-motion, and the gear is sometimes erroneously called a link-motion, but though its effect is the same as that of a link-motion, the principles of its construction are radically different. The determination of the proper proportion of the parts of the gear and of the effects of modification can be determined by trial only, making use either of a series of diagrams like Fig. 1 or of a model, which can be conveniently made of wooden rods.

C. H. PEABODY.

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In reply to your correspondent who wishes information relating to the Walschaert valve gear, I would say that he will find the subject discussed, with diagrams and explanatory matter, in the following books:

| | | |
|---|---|---|
| Treatise on Valve Gears | Zeuner | p. 127 |
| Link and Valve Motions | Auchincloss | p. 121 |
| Valve Gears for Steam Engines | Peabody | p. 88 |
| Appareils de Distribution par Tiroirs | Pichault | p. 141 |

This gear is equivalent to that known as the link of Hensinger Von Waldegg, and in Zeuner it appears under that name, while Pichault refers to it under both names, and the other authors mentioned refer to it as the Walschaert gear. D.

I notice that a party signing "H." requests information regarding the Walschaert valve motion, and I would say that it is described, and manner of laying out the diagram given, in "Link and Valve Motions," by W. S. Auchincloss. The Walschaert valve motion is used on some European locomotives and also on some of the compressed air locomotives in this country, where it is impracticable to put in the ordinary link. SCHENECTADY, N. Y.

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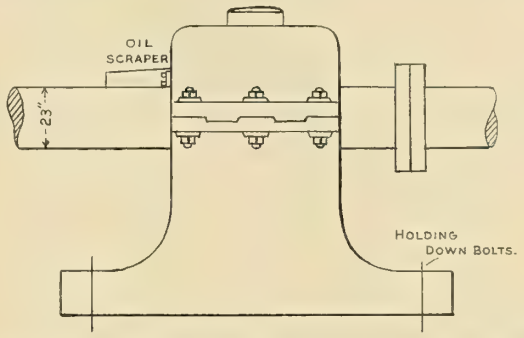
### Device for Saving Oil in Shaft Alley.

When on the S.S. Campania recently, I noticed a simple yet practical device intended to prevent the lubricant from traveling along the main shaft, a very undesirable thing, as it means a dirty looking shaft and men's time to keep it clean. The diameter of the main shaft is about 23 in. At the side of each of the bearings a small piece of steel, or wrought iron, which has an elbow (at an acute angle) on it, is bolted to




OIL SCRAPER ATTACHED TO PROPELLER SHAFT BEARING.

the cap of the bearing by two small set screws, probably 3-8 in. The long end of this angle piece is about 5 in. It is about 3-8 in. thick and 1 in. wide. When in place, this piece is made to just touch the shaft, and is placed at a slight angle with the center of the shaft. This simple device has acted quite successfully, and below the shaft is a receiving tank, into which the oil now drops, instead of traveling along the shaft for two or three feet, as formerly. I never saw this before and it struck me as rather ingenious. I enclose sketch. J. J. S.

---

### A Response to Inquiry of "B. T. U."

With regard to the inquiry of your correspondent "B. T. U." in the October issue, our conclusion on this matter is that no definite reliable data is available regarding the conductivity of metals in Feed Heaters, Condensers, etc. Our experience is that the conductivity varies considerably, according to the construction of the apparatus. We would refer him to D. K. Clark's "Rules, Tables and Data," where a number of results are given, obtained by various experimenters. This will be found in the section of "Applications of Heat." G. & J. WEIR, LTD.,

GLASGOW, SCOTLAND.

(The work referred to is entitled "A Manual of Rules, Tables and Data for Mechanical Engineers," by Daniel Kinnear Clark, M.I.C.E., published by Blackie and Son, Old Bailey, London, E. C.—Ed.)

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### Regarding the Position of Screw Propellers.

As there is a great difference of opinion on the following problem, I would like some of your readers to discuss it. Is it disadvantageous, and to what extent, in a twin screw steamer, to have the shafts farther apart at wheels than at engines; or, in the case of a single wheel, to have shaft say 3 ft. off the horizontal? PROPELLER.

# EDUCATIONAL.

## ELECTRICITY ON BOARD SHIP, PRINCIPLES AND PRACTICE.—VI.

BY WM. BAXTER, JR.

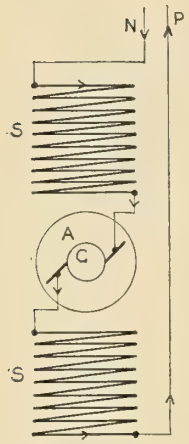


FIG. 36.

In addition to the four types of two pole machines given in the preceding article, we present herewith three more, which complete the list of prominent types. Machines like Fig. 31 were made extensively, in former days, by the Weston Company, in this country, and by Siemens & Halske and others, in Europe. Fig. 32 is the Gramme machine, which was made in several countries on the other side of the Atlantic, and is still made as an arc light machine in this country, being, in fact, one of the most prominent machines of that class. The Brush "arc" machine is the most prominent of type 33. These three machines are of the two circuit variety, and differ from each other only in that the armature is either changed in form, or in the position of its axis. In Figs. 32 and 33 will be noticed the shaft runs parallel with the length of the frame, while in Fig. 31 it is transverse. The only difference between 31 and 32 is in the position of the shaft, for although as a rule a drum armature is used with the former and a ring armature with the latter, either style of armature may be used in both. The difference between Figs. 33 and 32 is that the field magnets on opposite sides, instead of coming together to form single pole pieces, are separated and the armature rotates between them.

As was shown in the last article, a single magnetic circuit machine should give the best results, theoretically, but in practice the difference is not very great, owing to the fact that when two circuits are used the area of each one can be made more than half the area of the single circuit without any difficulty, and therefore the total number of lines of force can be obtained with a less number per square inch of cross section, hence with a smaller number of turns of wire in the coil. In this way the apparent gain of the single circuit type is largely offset, and with sufficient skill on the part of the designer can be wholly offset.

The amount of electric energy required to magnetize the machine is not the only point that determines its efficiency. The magnetism may be developed with a small expenditure of energy, but it may not be all utilized, and the loss in this direction may be far greater than the gain in the former. The lines of force developed by a coil tend, when they emerge from it, to find their way back to the other end by the easiest path possible, and if there is any chance for them to return to the coil by a path outside of the armature with less effort, they will do so, and therefore the full effect of the magnetizing current will not be made available. A parallel to this may be found in a steam engine which is so well designed that it should work very economically, but is provided with a piston of such construction that it cannot be kept tight, therefore, the loss due to the leakage of steam from one side to the other is sufficient to overbalance all the good points, and render the engine as a whole decidedly inferior. The difference between a steam engine with a defective piston and an electric machine in which the magnetism of the field can leak by the armature is that the former can be remedied, if need be, by the substitution of a better piston, but in the electrical machine about the only remedy is to replace the field, and this would be very nearly equivalent to replacing the whole machine.

The difference between an efficient and an inefficient electric machine is not dependent upon the type to which it belongs except in a very small degree, but to the relative proportion and shape of the various parts.

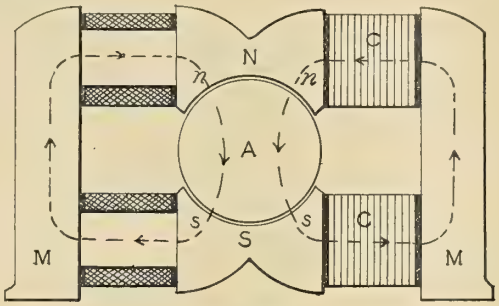


FIG. 31.

From what has been said in this and the preceding article it can be seen how the energy required to develop the magnetism can be reduced to the lowest point, and in a future article we will show how to utilize in the armature the greatest proportion of the

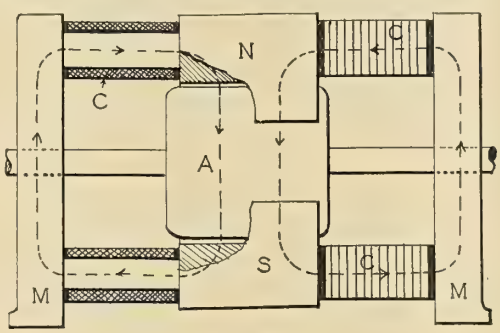


FIG. 32.

magnetism. We will now explain the manner in which the magnetizing coils are wound, and how to determine what ends should be connected when there are a number of coils.

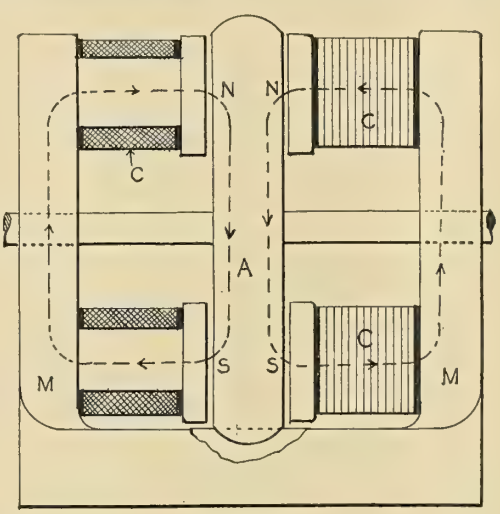


FIG. 33.

In the simplest form of machine, that shown in Fig. 27 of the last article, the coils must be wound so that each one develops lines of force oppositely directed

in space; if not, one will act against the other, and there will be no lines of force to pass through the armature. In Figs. 28, 29 and 30 the winding of the coils must be such as to develop lines of force in the same direction through space. In Figs. 31, 32 and 33 the coils of each circuit must be wound so as to develop lines of force oppositely directed through space, but the relation of the coils of the two circuits must

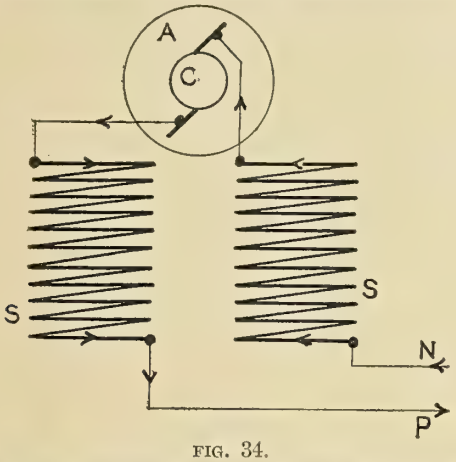


FIG. 34.

be such that the direction of the lines of force of both circuits will be the same through space. How to accomplish this can be made clear by the aid of Figs. 34, 35, 36 and 37.

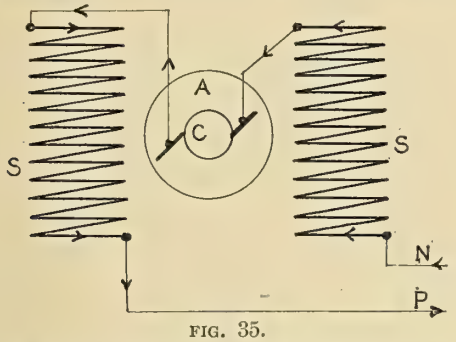


FIG. 35.

Fig. 34 is a diagrammatic representation of the field coils and armature of machines of the type shown in Fig. 27. Fig. 35 corresponds to types 28 and 30, Fig. 36 to type 29, and Fig. 37 to types 31, 32 and 33. In all

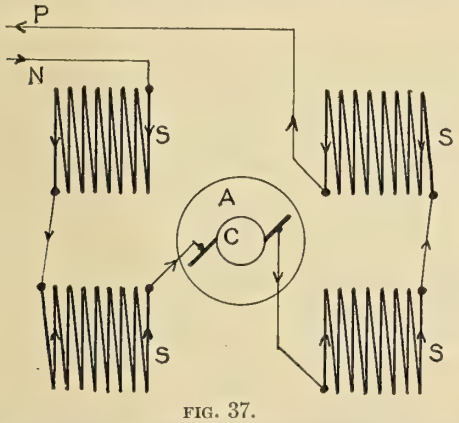


FIG. 37.

these diagrams A represents the armature, C the commutator and S the field coils. P and N are the wires through which the current passes to the outside circuit; and the arrow heads on these may be taken to represent the binding posts to which the leading off mains are attached.

Considering Fig. 34 it is evident that, as the coil on the left side must magnetize the field with an N pole at the top, while the coil on the right must develop an S pole at the top, the direction of the current through the wire in both must be in opposite directions; that is if it flows through one in the direction of a right hand screw, its direction through the other must be that of a left hand screw; but, as the current passes out of the right hand coil at the top, and enters the left hand coil at the top also, the wire must be wound in the same direction in both coils. To understand this more clearly, suppose the right hand coil were revolved around through one half turn so as to come directly on top of the left hand coil, then the two coils could be regarded as halves of one and the same coil, and the wire in each half would be wound in the same direction, and the current through both would also be in the same direction. To make the matter still clearer, suppose we wound a single coil equal in length to the two coils, and pulled this apart in the middle and bent the two halves around, so that they would come side by side. All we would have to do then would be to cut the wire at this middle point where we bent the coil, and connect the ends with the two brushes resting upon the commutator C.

In Fig. 35 the direction of the current through each coil would have to be the same. This arises from the fact that while in Fig. 34 one coil develops an N pole at the top and the other an S pole, in Fig. 35 both coils develop like poles at the top.

In Fig. 36 the current must flow in the same direction through both coils, notwithstanding that this is also a single magnetic circuit machine, the same as Fig. 34. The current through both coils is the same in direction, because one is on top of the other, and, as was explained in connection with Fig. 34, if the current is in the same direction in both coils, when one is on top of the other, it will be in opposite directions when they are bent around side by side. The two coils in this figure may be regarded as halves of the same coil, spread apart in the middle (the wire being unwound sufficiently at this point to permit the halves to be drawn apart), the wire being cut in two at this point and the ends connected with the brushes resting on the commutator.

Fig. 37 is the winding diagram for Figs. 31, 32 and 33, and by studying these figures we will see that the direction of the current through the four coils must be such that the two right hand coils will develop an N pole at the top and an S pole at the bottom on the left hand side of the coils, and that the coils on the left side must develop the same poles on the right hand side of the coils. This being the case, the winding of the two coils on the left must be the same as that of the coils in Fig. 34, and that of the left hand pair must be the opposite of this.

It will be noticed that in all these diagrams the brushes do not rest upon the commutator in the same place. In Fig. 34 they are on top and bottom and in the others on the sides. This change in position is due to the fact that in every case they must be opposite the spaces between the poles unless the connections between the armature and commutator are carried around the circle, as is done in the Edison and some other machines, for the purpose of bringing the brushes into a more accessible position.

In making the connection between the ends of the field coils and the commutator brushes it makes no difference to which brush either end be carried, unless it is desired that the armature revolve in a certain direction, but as the direction of rotation can be reversed by simply reversing these connections, it is generally less trouble to determine the proper relation by actual trial than by tracing out the direction of the current through the armature. The latter method is also simple, and as it is desirable to know the relation between the direction of the current in armature and field, the way of determining it will be explained at the proper time.

# ENGINEERS' DICTIONARY.

**Air Casing.**—A casing of sheet steel or iron, placed about the smoke pipe where it passes through the decks, or from the fireroom to the upper deck. Its purpose is to provide protection from the heat of the pipe, and ventilation from the fireroom to the external air through the annular space between the pipe and casing.

**Air Chamber** or *Air Vessel.*—A chamber connected with the delivery side of reciprocating pumps handling liquid, and containing air in its upper part. The average pressure of the air thus imprisoned will be that on the delivery side of the pump. Under this pressure the air will become compressed into a relatively small volume. As the pressure due to the pump piston tends to fall between strokes, the compressed air will expand and thus tend to continue the delivery, until the piston again takes up the work on the following stroke. The presence of this body of air, capable of compression or expansion, is also valuable for the absorption of shocks in the delivery pipe, due to the irregular speed of the pump, or the irregular yielding of the resistance against which it is working. As a safe general rule the volume of the air chamber may be made about the same as that of the water cylinder of the pump.

**Air Cock.**—In general, any cock used to control the flow of air. In particular, a small cock on the delivery side of pumps, for the escape of air and to show if the pump is operating properly.

**Air Duct.**—A closed passage or channel for leading air to or from blowers and ventilating fans.

**Air Lock.**—An arrangement of double doors and intermediate chamber or lock A (Fig. 1), with valves

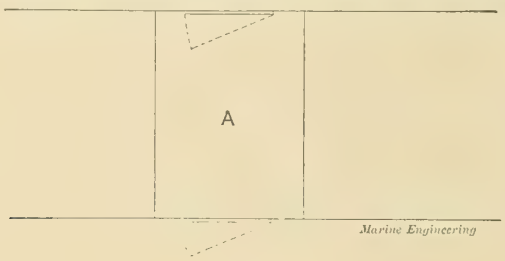


FIG. 1.

for equalizing the pressure within with that on either side. By this means passage to and from firerooms, under forced draft pressure, may be effected.

**Air Pump,**—A pump for the removal of air, condensed water and vapor from the condenser, in order to maintain the vacuum formed by the condensation of the steam. The air comes from leaky joints, and from the gradual accumulation of the small amount naturally mixed with the feed water. The usual type of air pump is illustrated in Fig. 2[1]. A is the *piston* or *bucket* moving in the barrel B. The valves at C are known as *foot valves* and admit the contents of the condenser from below. Beginning with the piston in the position shown, the operation is as follows: As the piston rises the air and vapor in the space between it and the foot valves become rarified with a resultant decrease of pressure. Soon a point is reached where the pressure is decidedly greater in the condenser than in the space above the foot valves, and in answer to this difference of pressure the valves open and admit air vapor and water from the condenser. This operation terminates with the piston at the top of the stroke. On the return stroke the foot valves close, and the contents of the barrel are forced through the *bucket valves* at D to the space above. On the next stroke these contents are lifted and forced out through the *head* or *delivery valves* at E, where the air and vapor escape, and the water flows to the hot well whence it is sent by the feed pump back to the boiler. It is evident that the pressure in the condenser cannot be reduced below that necessary to raise the foot valves, so that for this reason, as well as for their more ready response to variation of pressure, they should be made as light as is consistent with a proper performance of their duty. Such valves in modern practice are usually made of light sheet metal, controlled by dished spiral springs. In older practice vulcanized rubber was commonly employed. It is also evident that the foot valves will respond the more quickly, the more rapidly the pressure above them decreases as the piston begins to rise, and hence the less the clearance space between the valves and piston when in its lowest position. The air pump has this peculiarity in its action, that the load per stroke and hence the resistance, usually decrease with an increase of speed, and increase with a decrease of speed. Hence, when the pump is operated by an independent engine, it may be liable, unless carefully designed, to race or run away to excessively high speeds, with a slight increase of pressure in the steam cylinder, or to slow down and stop with a like decrease. It is apparent also that a certain time will be needed for the

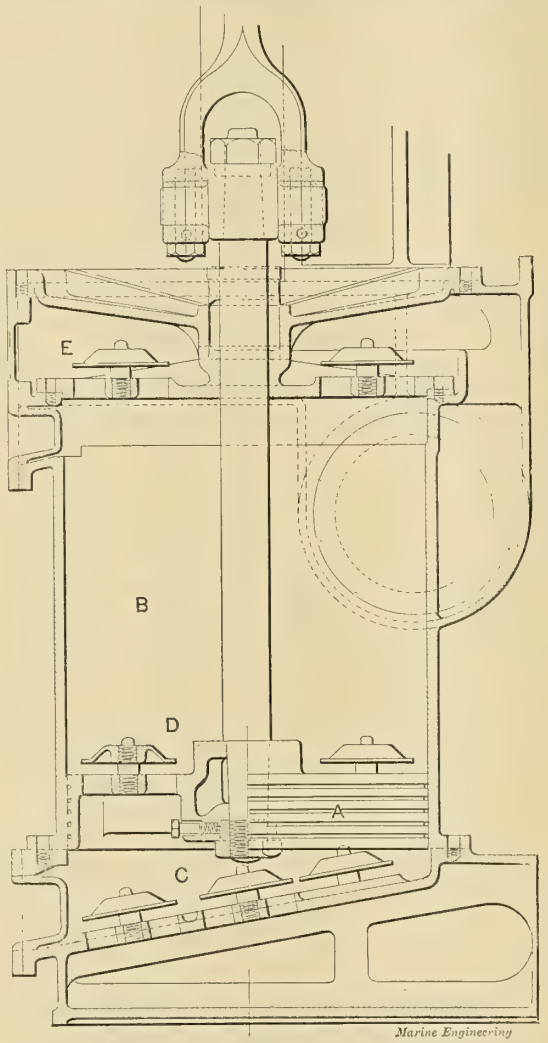


FIG. 2.

foot valves to open, and for the air, water and vapor to flow through. Hence, with excessive speeds, the valves may not have time to open between strokes, the vacuum will become poorer, and the condenser may become flooded with the condensed water. It thus follows that, with too high as well as with too low a speed, the vacuum will be poor, and the opera-

[1]The Rubber valves are not in place in the sketch.

tion of the pump unsatisfactory. The air pump may be driven either by an independent engine, or by attachment to the main engine. The attached air pump is usually operated by *air pump levers*, which derive their motion in most cases from the L.P. cross-head. The stroke of the pump is thus reduced to usually less than one-half that of the main engine. One of the advantages of the attached air pump is that the number of its strokes per minute is necessarily the same as for the main engine, and it can neither race nor slow down, on account of variations in its own resistance. A further advantage is that the power required for its operation is obtained more economically than if it were operated by a separate engine. The chief disadvantage of the attached air pump is that, with modern increase of revolutions, the speed may be too great for the best results from the pump, as usually designed. This, together with the advantage of having the condition of the condenser under control, independent of the main engine, is bringing about a more general use of the independent air pump, especially in war ship design. In such case the number of double strokes per minute is usually from 15 to 25, while the revolutions of the main engine may be from 100 to 200 or more. For special cases of torpedo boat practice, where the revolutions are very high, but it is desirable for simplicity and for the saving of space to use an attached air pump, a special type has been developed in which the water flows by gravity into the barrel through ports alternately opened and closed by the piston itself, which thus serves as its own valve. The air and vapor naturally expand and enter with the water, and the whole contents are forced out of the end of the barrel through delivery valves similar to those in the pump of usual type. With this design, air pumps may be successfully operated at speeds of 400 revolutions per minute and higher. A wide variation in practice exists in the design of the capacity of air pumps. The volume may be proportioned either to the power developed by the main engine, or to the volume of the L.P. cylinder. If $v$ is the volume displaced by the air pump piston per stroke, $n$ the number of double strokes, then we may put:

$$v = \frac{(\text{I. H. P.}) \times C}{n}$$

where for independent pumps c may vary from 50 to 100, and for attached pumps from 100 to 250.

Or, if V is the volume of the L.P. cylinder, we may put:

$$v = \frac{V}{10} \text{ to } \frac{V}{20}$$

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The "Practical Engineer" pocket book, for 1898, published by the Technical Publishing Company, 31 Whitworth street, Manchester, England, is just what its name implies. It is a most convenient little work of 374 pages, in which is stored up ready for immediate use a great variety of data of the most practical character, such as would be needed daily by any constructing engineer ashore. To give a list of all the data the book contains would occupy much space, but a few of the leading divisions will give a correct idea of the contents. Tables of British and Foreign Measures; Boilers, including Construction, Incrustation, Tests and auxiliary apparatus, such as Feed Pumps, Injectors, etc.; Engines, giving rules for Proportions, Properties of Steam, Engine Testing and indicator work; also data regarding Steam Pipes, Strength of Materials, which included crank and propeller shafts, is followed by a chapter on Friction and data concerning methods of Power Transmission. Gas and Oil Engines are reviewed and Hydraulic Machinery also. A chapter on Workshop Practice takes note of the speeds of cutting tools. Hoisting Machinery, Mining Machinery and Electrical Engineering, all get considerable space. The only criticism which occurs to us is with reference to the typographical features of the work. It is as a whole badly printed on poor paper, but the low price, one shilling and sixpence, makes this, perhaps, excusable.

## DURING THE MONTH.

The Commercial Cable Co. decided to erect new towers at Fire Island, Sandy Hook, and Highlands of Navesink, from which to report passing vessels.

The British torpedo-boat destroyer Crane is credited with a speed of 32.49 knots on the measured mile in a recent trial. Probably this was with the tide.

The new steamship Miami, built by the Cramps for Henry M. Flagler, to ply between Miami and Nassau, N. P., made a successful trip and will soon leave for her station.

A company formed to build the Parsons steam turbine has decided to establish extensive works at Wallsend-on-Tyne, on the east coast of England, where, not only turbine engines, but hulls will be built.

A contract has been drawn up between the Western Transit Company and the Detroit Dry Dock Company for the construction of a new 400 ft. steel steamer. She is intended to carry 5,000 tons on a 17 ft. draft.

A movement was started among the business men of St. Louis to establish a steel barge line to trade between St Louis and the Gulf. An estimate for $500,000 has been made and the larger part of this sum subscribed.

Fire destroyed the wooden steamer George Morley, on Lake Michigan, early in the month. She was bound light from Milwaukee to Chicago, and after she caught on fire was run ashore near Evanston. She was valued at $35,000.

French Naval authorities have included in the new shipbuilding program 112 first-class torpedo boats, of which about two dozen will be completed within a year. In destroyers they have decided upon a small number of boats of more than 300 tons.

The trip of the British cruiser Powerful from England to a China station is being watched with a considerable amount of interest, as she represents the largest installment of water-tube boilers in any fast vessel afloat, being fitted with those of the Belleville type.

A contract has been concluded between the Cramps and the Boston Fruit Company for the construction of four steel screw steamers of about 2,500 tons carrying capacity, which are intended to trade between the West Indies and Baltimore, Philadelphia, Boston, and New York.

Plans for a new form of automobile torpedo were approved by the British Naval authorities and experimental torpedoes are to be made. The new weapon is said to possess many advantages over the Whitehead. This same promise has often been made in the past, but so far the Whitehead retains its supremacy.

The British Government has let a contract to construct a harbor at Dover, on the southeast coast of England, directly opposite Calais, on the French side. The contract price is $20,000,000. It is the intention to use this harbor as the headquarters of the squadron of fast cruisers and torpedo boats, and also as a harbor of refuge in case of war.

There was a change of ownership of the Thingvalla line, which maintains a regular service between this port and Christiana, Copenhagen and Stettin. This is understood to make available a large amount of new capital, with the probability that additions will be made to the fleet, which now consists of the liners Norge, Hekla, Island, and Thingvalla.

An award of $18,000 has been made by the English courts to the Dominion liner Memnon for salvage services rendered to the Anchor liner Circassia, last September. The latter broke her shaft while east bound from New York and was towed several hundred miles to Queenstown by the Memnon. This division of the award was made: Owners, $13,250; Master, $1,750; and Crew, $3,000.

A direct steamship line to India was inaugurated by the sailing of the S.S. Sahara from the Atlantic Docks, in Brooklyn, with a cargo of steel rails, machinery and case oil. This line is established by the London firm of Bucknall Bros., and the agents here are Norton & Son of the Produce Exchange. Hitherto freight for points in India has been trans-shipped, going by way of British or Mediterranean ports.

The steam launch Ellide, built by Samuel Ayres & Son of Nyack, for E. Burgess Warren, from the designs of C. D. Mosher, was accepted by the owner. A bonus of $6,000 is said to have been paid by him for speed in excess of 30 miles an hour. Mr. Warren is credited with the proposition of offering the launch to the Navy Department for experimental work in connection with the construction of torpedo boats.

The steamer Rosedale, loaded with 60,000 bushels of wheat from Ft. William to Montreal, struck on the Charity shoal, near the head of the St. Lawrence river, and was abandoned. This vessel, which was owned by the Montreal Transportation Company, was built in England and cost about $75,000. She was said to have been the first steel vessel that ever carried a cargo from the British Isles through to Chicago.

**While the Allen State liner State of Nebraska was** on her way out of port, December 9, she was run into by the coal barge C. C. Chapman, in the channel just inside the Hook. The stubby bowsprit of the wooden barge struck the liner just abaft the port lighthouse and tore away a number of the cattle pens, many of the beasts escaping into the sea. Beyond some damage to the joiner work, no serious injury was sustained by the liner, which however put back for repairs.

Particulars of the machinery for Queen Victoria's new yacht were given out. Humphrey's Tennant & Co., London, are the contractors. The yacht is to be 380 ft. long, 50 ft. beam, and 18 ft. draft, and to displace about 4,600 tons. The hull will be built at the Royal Pembroke Dock Yard. The yacht is to be minutely subdivided into water-tight compartments and is to be sheathed. She will have twin screws, with four-cylinder, four-crank triple expansion engines. These will have cylinders 26 1-2 in., 44 1-2 in. and two 53 in. by 39 in. stroke. At 140 revolutions, with 250 lb. pressure, a total of 11,000 horse power is estimated. Steam will be generated in eighteen water-tube boilers of the Belleville type, having a total heating surface of 26,000 sq. ft. and grate area of 840 sq. ft. The boiler pressure will be 300 lb. per sq. in. reduced at the engines. The yacht will have three smoke stacks and two pole masts.

The big freight steamer Monarch of Elder, Demster & Co., met with a run of bad luck upon her first eastward voyage. She left New Orleans November 5, for Liverpool, with a cargo which included 22,535 bales of cotton, 60,000 bushels of corn, 11,200 sacks of cotton seed meal, and 29,068 pieces of oak staves, which was probably the largest cargo ever loaded at New Orleans. When a little way out to sea, a mishap to the machinery compelled the steamer to put back for repairs. When she came to anchor again in port she was run into by the steamer Kinsale, which had cleared with a cargo of corn for Rouen, France. The rudder chains of the Kinsale had snapped, and while unmanageable she crashed into the starboard side of the Monarch. Both vessels were considerably damaged, a hole about 10 ft. square being torn in the bow of the Kinsale and several plates of the Monarch were started, letting in a considerable amount of water. The Kinsale was towed back to her wharf, and it is reported that only for her watertight compartments she would have sunk. On the Monarch the pumps were easily able to keep the water down, and subsequent repairs were not very extensive. The damage to both vessels was estimated at $40,000.

# QUERIES AND ANSWERS.

Q.—In talking about modern high speed boats reference is often made to the horse power developed per ton of machinery. Is it not a fact that in some of the experimental flying machines as great, or greater, results were obtained in this direction as in any boat yet built? S. K.

A.—In a flying machine built by Hiram S. Maxim, the motive power was furnished by a compound engine with cylinders 5 in. and 8 in. by 12 in., which developed 300 horse power with 325 lbs. boiler pressure. The boiler was of the water-tube type with 600 tubes, 1-2 in. dia. and highly inflammable liquid fuel was used. The weight of the boiler and engine was about 1,900 pounds or about 6 1-2 pounds per horse power. In the 100 ft. experimental boat Turbinia the total of machinery weights was 22 tons, and as the engines developed considerably more than 2,000 horse power, this figures out about 22 pounds per horse power. These figures include, however, the weights of auxiliary engines and condenser, reversing turbine, and shafting and propellers, of which there were nine. In some of the later British torpedo-boat destroyers the weight figures out about 50 pounds per horse power by trial data. In the case of the torpedo boat destroyer No. 11, now building in this country, the estimated weights and power show approximately 43 pounds per horse power. An exact comparison cannot, of course, be made as the purposes of design and use are so dissimilar in vessels and flying machines, and again the weights given for the latter do not apparently include the mechanisms for operating the wings or vanes while in the case of the Turbinia the entire propelling apparatus is included.

Q.—Will you give me a rule for setting a spring loaded safety valve? R. S.

A.—Supposing the spring is made of square steel, multiply the pressure per sq. in. at which the valve is to lift, by the square of the diameter of the valve, by .02618, by the cube of the mean diameter of the spring, and by the number of coils in the spring, and divide the product by the fourth power of the thickness of the steel in sixteenths of an inch, the quotient will be the required amount of compression in inches. The mean diameter is measured across the coil from center to center of the steel, or in other words, is the outside diameter less the thickness of steel from which the spring is made. If the spring is made of round steel, substitute the constant .03454 for .02618 as above. Example: Take a 4 in. valve to lift at 100 pounds pressure with a spring 3 5-8 in. outside dia. and made of 11-16 in square steel, with seven coils. The square of the dia. is $4 \times 4 = 16$. The mean dia. of the spring is 3 5-8 — 11-16 = 2 15-16 = 2.9375 and the cube of this is $2.9375 \times 2.9375 \times 2.9375 = 26.973$. The number of coils is 7. The thickness of the steel in sixteenths is 11 and the fourth power of 11 is $11 \times 11 \times 11 \times 11 = 14,691$

Then: $$\frac{100 \times 16 \times .02618 \times 26.973 \times 7}{14,641} = .54$$

The spring will thus need to be compressed .54 in. As the elasticity of springs of the same dimensions varies, it is well to verify the rule by a practical test.

Q.—I would like to have a ready method of testing bituminous coal? RYAN.

A.—Place a grain of powdered coal in a platinum crucible, of known weight, heat to a temperature of 250 deg. F. until the coal is dried, when the weight will be constant. The moisture will be represented by the loss in weight. Now close the crucible containing the dried coal with a tight lid and apply heat gradually up to a bright red, using preferably a Bunsen burner. This will liberate the volatile hydrocarbons, and when this is accomplished cool off the crucible and again weigh it. The difference in weights will now give the amount of volatile matter. Now replace the crucible over the flame with the lid off and keep up the heat, so that the fixed carbon will be burned off. The ash will remain. Weigh this with the crucible and afterward the crucible alone and the difference will give the weight of ash. It will be necessary to use an accurate balance and also to conduct the experiment with care, as the quantity of coal is extremely small, and a slight error in the determination would mean misleading results when applied to large quantities. Great care should also be taken that the sample represents the average quality of the coal to be tested.

Q.—Why do high speed engines have a short stroke as compared with the diameter? F. B.

A.—Because they can be run at a high rotative speed without exceeding the limit of piston speed. A disadvantage of the type is the comparatively large proportion the clearance bears to the volume of piston displacement. An advantage is the high average temperature of the parts exposed to steam, causing less condensation wastes.

Q.—Can you give me a good way to clean a dirty dynamo? W. J. M.

A.—The dynamo should not have been allowed to get dirty. However, remove as much as possible of the dirt and grease from the armature and fields with a soft cloth. Then get a gasoline torch; fill it with benzine and, after pumping it up, spray the coils and follow quickly with a sponge cloth. Then apply a thin coat of shellac and leave the machine to dry before starting up.

Q.—Can you give me any rule for figuring the thickness of copper pipe necessary to withstand a given pressure? R.

A.—The rule adopted by the U. S. Government Supervising Inspectors, is to multiply the working steam pressure, in pounds per square inch, allowed on the boiler by the diameter of the pipe in inches, and divide the product by the constant whole number 8,000 and add .0625 to the quotient. This gives the required thickness in fractions of an inch. Thus to find the thickness of an 8 in. pipe connected to a boiler carrying 160 pounds of steam per sq. in.

$8 \times 160 = 1{,}280$

$8000 \overline{)\,12800\,(.16}$
$8000$

| | |
|---|---|
| 48000 | .16 |
| 48000 | .0625 |
| | .2225 |

which would be equivalent to No. 5 B. W. G.

Q.—Would there be any more economy in using steam at 100 pounds pressure and by expansion making the mean effective pressure 70 pounds, than in using steam of 70 pounds throughout the stroke? P. M.

A.—Suppose the volume of the cylinder to be one cubic foot, then by using an initial pressure of 70 pounds and continuing it throughout the stroke a cubic foot of 70 pound steam weighing .201 pound would be used at each stroke. By using 100 pound steam a mean effective pressure of 70 pounds would be got by cutting off at 3-8 stroke. As 100 pound steam weighs .264 pound per cubic foot, 3-8 cubic foot would weigh 3-8 of .264 = .099. Thus only .099 pound would be used at each stroke, cutting off as above as against .201 pound of the 70 pound steam. This is simply an explanation; in an actual case clearance would have to be considered to get accurate figures and then too in practice the actual gain would not equal the theoretical owing to the increased effect of cylinder condensation as the ratio of expansion increased.

Q.—What qualifications are necessary for enlistment as a machinist in the U. S. Navy? T. B. S.

A.—First that the applicant be a machinist by trade. This is the most important qualification. It is, of course, necessary too, that the applicant be in good physical condition and be possessed of sufficient education to understand drawings and measurements, and be able to do simple figuring. Application should be made in person at one of the receiving ships at Boston, League Island, or Norfolk, or in your case at the New York Navy Yard. An applicant under 21 years would have to show the consent of parents or guardians, but there is no maximum age limit fixed. The applicant would be examined practically by the Engineer Officers of the Navy and would have to pass the scrutiny of the Naval Surgeons.

Q.—Does the license of an engineer apply to the gross or net tonnage of a boat? N. Y.

A.—The gross. An engineer who holds a license for certain tonnage can serve in a vessel of a larger capacity, provided the engine in the larger vessel does not exceed in power that of the vessel for which his license was issued.

Q.—What was the date of the launch of the iron-clad Dunderberg, afterward the Rochambeau of the French Navy? A. T.

A.—She was launched July 22, 1865, from the yard of Webb & Roach on the East River.

Q.—What is meant by B. T. U? OILER.

A.—British Thermal Units. A unit of heat, or British thermal unit, is the amount of heat required to raise one pound of water (through one degree of temperature at its point of maximum density) from 39 to 40 deg. Fahrenheit.

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An example of progressive practice comes from where it would be least expected—Spanish ownership. The steamer Riojano, formerly the Borderer, has recently been fitted with new machinery at Liverpool. She has now quadruple expansion engines, with a working pressure of 240 lbs. per sq. in., with forced draft. She is reported as having made a very successful trip.

To aid in making the British Royal Naval Reserve more effective, the Admiralty has established a course of instruction for engineer officers of the mercantile marine who are members of the reserve. This is located at Portsmouth, where there are great facilities for inspecting work during construction, attending trial and special trips, and viewing various types of engines and apparatus on board warships. The engineers attending the class receive the same pay that they would get on active service, and besides a lodging and provision allowance. The course lasts about three months.

### Important Salvage Suit Decision.

A reduction of an award for salvage services from $27,500 to $16,666 was made in the U. S. Circuit Court of Appeals at Richmond, Va., recently, in the case of the British steamer Haxby. A libel had been filed by the Merritt Wrecking Organization of New York in the District Court for the Eastern District of Virginia, and Judge Hughes awarded the salvors $27,500. The owners had admitted the meritorious character of the service, but disputed the reasonableness of the amount claimed, and it is understood they offered to pay $15,000 before the commencement of the suit. They accordingly appealed, and the details, as given in the opinion of Circuit Judge Goff, are of interest.

The Haxby is a modern steel vessel fitted with triple expansion engines of 3,445 gross tons, 330 ft. long, 43 ft. beam and 21 ft. deep. She went ashore at night abreast of Dam Neck Life Saving Station, on the eastern shore of Virginia. Though drawing 12 to 15 ft. of water, she crossed a shoal over which there was only 6 ft. at low tide. She lay about 30 ft. from the beach at low water, and broadside on. The wrecking concern next day arrived with an outfit and got the Haxby off, towing her to Newport News. For this work they claimed $40,000. The value of the property they employed was about $117,000, and there was a crew of 24 men. The Court recognizes the skill displayed, but adds that the risk to life or property was only such as might be expected in such work. When the Haxby was delivered at dry dock she was badly damaged, and it was "clear from the evidence" that the injuries were received after the salvors commenced their work. At the time the vessel was delivered in dry dock her value did not exceed $100,000. Taking into consideration the courageous manner which the salvage work done and having regard to all the risks run, the Court decided that one-sixth of the value of the property saved would be fair to the salvors and just to the owners of the vessel. This amounted to $16,666, and an order was made remanding the case back to the Court below, with instructions to enter up the modified decree. This important case was argued by Robert M. Hughes, of Sharp & Hughes, Norfolk, Va., for the salvors, and by George Whitelock, of Schmucker & Whitelock, Baltimore, Md., for the owners of the Haxby.

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The "Record of American and Foreign Shipping," just issued, is the thirtieth annual of the American Shipmasters' Society. Careful examination of this volume of reference shows that the compilers have done their exacting work with much care. It contains no preface, or other apology for its existence, and wisely so, as the work itself is its best recommendation and a reminder at all times to those who may consult it of its exceeding usefulness. In the 1898 edition 17,000 vessels, ranging from the infrequent ketch to the full-powered transatlantic liner, and flying the flag of every nation, are alphabetically arranged, with much detail as to build, ownership and condition. This information, of course, forms the bulk of the annual, but there are many other interesting sections. These include the Rules for the Construction and Classification of Vessels built under the inspection of the Association, also Rules for the Survey of Machinery and Boilers, and for the installation of electrical apparatus on shipboard. Also names of vessels which have been changed, and lists of compound names arranged alphabetically by the last word of the name for ready reference. Lists of the officers and representatives of the association at home and abroad are supplemented by an accurate list of the names and addresses of the representatives of Marine Underwriters throughout the world. Altogether it is truly an invaluable book of reference for those who go down to the sea in ships, and more particularly for those who wait ashore for them to reach port.

## CATALOGUES.

**The first calendar for 1898,** and a neat one it is, is received from Robert A. Keasbey, 54 Warren street, New York. The heading is a basket of strawberries tipped over, natural in design and in the color of the berries.

**In marine work** tight joints are more necessary perhaps than anywhere else because of the difficulty in making repairs or securing duplicate parts. A little pamphlet on the subject is received giving a good deal of detail regarding the joints manufactured by the Tight Joint Co., 161 Bank street, New York.

**Vulcabeston for steam** and mechanical purposes has a catalogue devoted to it by the H. W. Johns Mfg. Co., 100 William street, New York. It is pocket size and contains a number of illustrations of washers, rings and gaskets, made from this material, together with an amount of descriptive matter, a list of sizes and some very strong testimonials.

**Users of signal lamps** will find it very useful to have on file a copy of the catalogue published by Russell & Watson, 145 Main St., Buffalo, N. Y. The catalogue describes this company's patent lens as applied to steamer and vessel signal lamps, also a full line of head lights, pier lamps, anchor and binnacle lamps, vessel torches and other marine supplies.

**A Klondike puzzle** is the holiday greeting which the Mason Regulator Co., 6 Oliver St., Boston, Mass., is distributing to its friends. It is very roundabout from Juneau to the heart of the Klondike, as every reader of Marine Engineering will find if he wishes to investigate the subject by sending for one of the puzzles.

**Fore and aft compound engines** manufactured by the Marine Iron Works, Station A, Chicago, are well illustrated in the folder issued regarding them. A full page drawing shows the detail of the engine and a large half tone illustrates the engine as set up and ready for use. These engines are made in various sizes and to suit all conditions. The detail of their design is told in the circular.

**The business of shipping** knockdown boats and launches as carried on by Fred Medart, boatbuilder, St. Louis, Mo., is illustrated in a folder just received. Every part of the boat is cut and fitted and the whole packed ready for shipping, so that the boats can be readily put together without difficulty. Amateur boatmen and others who are at all interested in the construction and building of boats will find this an interesting circular.

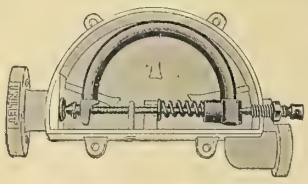
**A new motor which will interest yachtsmen** is being put on the market by the New York Compound Engine Co., 143 World Building, New York. The motor is an ammonia vapor launch engine, though the company also makes high speed steam engines. The catalogue just issued contains several illustrations of the ammonia motor and shows it installed in launches. A good deal of information is given, together with prices, weights, etc.

**Tobin bronze is familiar to everybody** connected with marine work, but few people can appreciate its qualities and many uses without studying the little catalogue, No. 181, issued by the Ansonia Brass & Copper Co., 19 Cliff street, New York. This catalogue is pocket size of 36 pages and contains very strong testimonials from some of the best known marine people in the United States. A copy of it should be in the hands of every man who has to do with such metals.


# 23 Years

in constant use — and no failures. Thousands of dollars saved by the "Heintz" Steam Trap. Simple — Durable — Efficient. Works in any position — discharges water to any height. No floats, no levers or delicate parts. Economizes fuel and labor — saves space — perfectly automatic—requires no watching. Money refunded if trap proves unsatisfactory within a year. Send for one on thirty days' trial free.

Booklet "G" for the asking, will show you how to save money.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

*"The Heintz—the best—tho' it has imitators."*

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# LAMPS

## For Every Purpose.

We make lamps for Yachts, Boats, Boathouses, Cabins, Wharves, Walks, or anywhere, indoors or out, where a good strong light is wanted.

Our goods need no recommendation from us. They are the standard. Other lamps are said to be "equal to," "like," or "as good as".

## THE NEW ROCHESTER.

To be sure the lamps offered you possess the merits peculiar to the genuine, insist on seeing the name stamped in the metal. Catalog free. We give as much attention to making special lamps, repairs, etc., as to our regular line.

## THE ROCHESTER LAMP CO.

**42 Park Place and 37 Barclay St., New York.**

# Graphite Lubrication

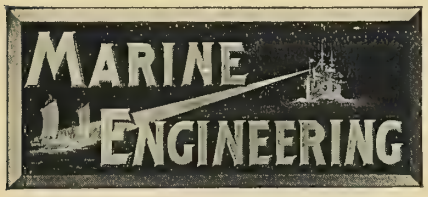
There is no substance known so smooth or so enduring as **Dixon's Pure Flake Graphite.** It is the best solid natural lubricant ever discovered. It is not affected by heat or cold, acids or alkalies. It is absolutely indispensable to every marine, stationary or locomotive engineer.

**It will pay you to send for Sample and Pamphlet. No charge.**

JOSEPH DIXON CRUCIBLE CO.,
JERSEY CITY, N. J.

## *Bound Copies.*

**VOLUME I. APRIL-DECEMBER.**




**Price, $3.50 Delivered.**

-:- Subscribers wishing back numbers
-:- to complete their files should order them at
-:- once as only a few copies remain of April,
-:- May and June.

MARINE PUBLISHING CO.,
WORLD BUILDING, NEW YORK.


**The King marine gasoline engine** is presented to the public in a very neat catalogue issued by the Charles B. King Co., Detroit, Mich. Unlike some catalogues of this nature, this one describes the mechanical features in such a way as to make the subject understood, giving such information as the user of an engine would most want to know. This company is also prepared to furnish launches of various types and sizes when called for, and they are illustrated in these pages.

**A catalogue has been issued** by John J. Tonkin, 609 Havemeyer Building, New York, descriptive of the Tonkin patent internally fired water-tube boiler. The general type of this boiler can readily be seen from the cut in the advertisement on the outside back cover of this magazine. Those wishing fuller details should send for a copy of the catalogue. Many features are of special value and some tests of unusual interest are given, together with a number of testimonials.

**To supply the large demand** for catalogues of its marine engines and launches the Daimler Motor Co., Steinway, Long Island, has issued a temporary catalogue of 42 pages, printed on coated paper, illustrating the various types of launches and boats, and also giving a good deal of detail regarding the motor. All the information one could ask for is contained within these pages, and every person interested should send for a copy. The launches and boats are of all sizes, from a 16 footer up to 85 ft. or 90 ft. or more.

**A four page supplement** catalogue is at hand from the Racine Yacht and Boat Works, Racine Junction, Wis. It contains pictures and drawings of a half dozen or more boats of various types manufactured by this company, from the small row and sail boat up to large cabin launches. Considerable space is given to the Midget, which is one of the special boats this company is pushing. A picture of this boat is shown in the advertisement on another page. The circular also contains picture and full description of the engine used in these small launches.

**Pneumatic tools of the type** shown in the advertisement of the Clement Pneumatic Tool Co., 125 South 11th St., Philadelphia, Pa., are fully described in a catalogue just received. These tools are extensively used in marine work for calking boilers, tanks and ships, for beading boiler tubes, for chipping, driving rivets and in many lines of submarine work. The several large illustrations in the catalogue tell very plainly the construction of the tools, and other illustrations show their operation. Copies of the catalogue can be had upon application to the company.

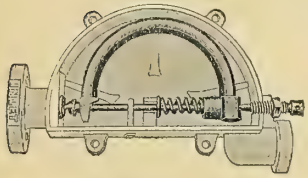
## BUSINESS NOTES.

NEW LAUNCH FOR THE REVENUE SERVICE.—A handsome launch just supplied by the Government to the revenue cutter Bear for service in the Arctic Ocean and Bering Sea has a Forbes engine, supplied by W. D. Forbes & Co., Hoboken, N. J.

GOOD REFRIGERATION.—A gentleman just returned from London, where he investigated the subject of delivering meats and other cold storage stuffs to the English market, reports that the American line has the reputation of giving the best results, the temperature evidently being more uniform and under exact control. The American line steamers are all supplied with Kilbourn machines, manufactured by the Kilbourn Construction Co., Drexel Building, Philadelphia, Pa.

# $1,100

lost in three days because he wanted his old traps to wear out before he put in the "Heintz"—a mistake one man made, resulting in a bursting of the cylinder head. Other steam traps "wear out" with a suddenness that causes damage—the repairs cost more than would all the traps used in a lifetime. The "Heintz" is a perfect trap—never wears out—never, under any circumstances, allows the water to back up. It works under all conditions. Our Booklet "G" tells about it.



William S. Haines Company,

136 South Fourth Street, Philadelphia.

*"The Heintz—the best—tho' it has imitators."*

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THE MASON REDUCING VALVE

FOR STEAM, WATER AND AIR.

Especially adapted for Marine Work in connection with heating, lighting and steam steering.

GIVES SATISFACTION WHEREVER USED.

Send for catalogue.

THE MASON REGULATOR CO.,

6 AND 8 OLIVER STREET,

BOSTON, MASS.

BOSTON & LOCKPORT BLOCK CO.,

BOSTON, MASS., U. S. A.

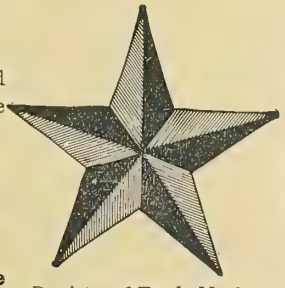
Manufacture everything in the Block, Sheave and Bushing line.

STAR

BRAND.

Send for free Catalogue of 112 pages, telling all about Blocks, etc.

**Specify Catalogue T, and name this paper.**



Registered Trade Mark.


TWISS MARINE ENGINES.—Nelson W. Twiss, New Haven, Conn., has recently sold a number of marine engines for use on boats in Long Island Sound and adjacent waters. These engines are designed to be rigid to make them capable of withstanding the hard usage frequently encountered on tugs, fishing vessels and other knockabout boats. They are made either simple, compound or triple-expansion. Small circulars have recently been issued illustrating these engines.

WHAT A WATER-TUBE BOILER GAINS.—The freight boat Clara, belonging to Charles L. Boyer & Sons, 90 Wall street, New York, is undergoing repairs for the purpose of making thorough tests of the Boyer water-tube boiler. The old boiler was of the return-tube type, using 100 lbs. pressure, having 28 1-2 ft. of grate surface, against 37 1-2 for the new boiler, 1,100 sq. ft. of heating surface, against 1,800 ft. to 1,900 ft. for the new one, and occupied a space 6 ft. by 11 ft., against 6 ft. 6 in. by 7 ft. 6 in. for the new boiler. Besides this reduction in space, the new steam plant will make a reduction of about 12 tons in weight.

A SATISFACTORY YACHT TENDER.—The following flattering letter explains itself: 817 Fifth avenue, New York, Nov. 24th, 1897. Marine Vapor Engine Co., Gentlemen:—I take great pleasure in adding this to the numerous testimonials which you have undoubtedly received endorsing your excellent motor. As far as my investigations go, it furnishes more power for its weight than any motor in the market. I found that I could carry, without inconvenience, in my 21 ft. launch for Calonia, a five horse power motor, from which I obtained surprisingly good results on several occasions when I found it necessary to tow my yacht. There are no unpleasant odors, and no excessive amount of noise. Very sincerely, C. A. Postley.

BIG CONTRACT FOR RIVER BOATS.—The contract for the construction of fourteen river steamers and twenty-four barges for the Yukon Co., of which Andrew F. Burleigh is president, has been secured by the Moran Bros. Co., of Seattle, Wash. Through an error, the ownership of these vessels was attributed to the Alaska-Yukon Co., in an article descriptive of the vessels building for the Klondike trade, on page 19 of our December issue. The Yukon Co. has headquarters in Seattle, and we understand that it will conduct most of the transportation business on the Yukon river during the coming year. The Moran Bros. Co. is to be congratulated on securing this extensive contract, which will give employment to a large force of men at their yards.

A FAST LAUNCH.—A launch has been built by the Spalding St. Lawrence Boat Co., Ogdensburg, N. Y., designed to be inexpensive, fast, and safe. The dimensions are: Length over all, 24 ft.; length on the water line, 23 ft. 6 in.; extreme beam, 4 ft. 8 in.; draft of hull, 8 in.; power, two H. P. Alco vapor motor, with a 17 in. wheel, 40 in. pitch. The engine is located about 6 ft. from the stern, and the oil tank the same distance from the bow, so that the center of fore and aft oscillation is short, and on account of the long decks at both ends, the boat is easy in a seaway. There are four water-tight bulkheads, so that there is no chance for the boat to be swamped, and in case of a hole in the bottom there is still sufficient air displacement to float. The lines are like the modern scientifically designed high speed yachts. The water line is very full aft, and the boat is entirely cut away underneath. The wheel is held on a bracket and a small fin, so that the center of axial resistance is far enough aft that the boat steers properly. Several speed tests were made on the St. Lawrence river over a surveyed mile, both with and against the current, and with a small sea, and the average was at the rate of 7.6 miles per hour. Several long runs were made, and from distances taken from the Government chart the average speed was 7 miles an hour against the current and 8 miles with it.

POPULAR STEAM DEVICES.—The four boilers of the S.S. Juniata illustrated in Marine Engineering for December were fitted with the Bloomsburg circulator and steam heating attachment, and one of the Bloomsburg jets was fitted in the donkey boiler stack. Bloomsburg circulators had previously been furnished for the "Gloucester" and also the "Howard," and jets for the donkey boiler stacks of the "Fairfax" and "Howard," sister ships. The Harlan & Hollingsworth Co. will make use of the circulators for the three boilers in the new yacht for Howard Gould, and Messrs. Bloomsburg & Co. have just delivered a jet for the 60 in. stack for the Norwich liner City of Lawrence. The contract for the Reading Railroad tug just closed with the Harlan & Hollingsworth Co. called for a Bloomsburg jet, being a duplicate of the one on the Reading tugs Catawissa and Tamaqua.

TO EXTINGUISH FIRES ON SHIPBOARD.—A new fire extinguisher for use on board vessels of all kinds is just being put on the market by the Underwriters' Fire Extinguisher Co., 2 Wall street, New York. The principle of the extinguisher is to generate dry carbonic gas by the proper combination of bi-carbonate of soda and sulphuric acid. The device is small and easily carried in the hand, and by simply reversing generates the gas, which can be injected into a fire by means of a hose and nozzle. Testimonials show that this gas will extinguish a small fire almost instantly. The enlarged principle as applied to steam vessels calls for thermostats in each coal bunker and in various parts of the holds, which actuate a central extinguisher connected to each center by means of pipes, so that in case of a blaze the device automatically operates itself and extinguishes the fire. We are informed the U. S. Navy has adopted the portable extinguisher for use on many war vessels.

## SPECIAL NOTICES.

*Announcements under this heading will be inserted at the uniform rate of thirty-three-and-a-third cents a line. Lines average ten words each.*

**POSITION WANTED.**

A marine engineer of 13 years' experience, licensed for a chief of 200 gross tons, or first assistant of 500 gross tons, desires position as engineer of a steam yacht or other vessel. Can take care of electric plant. Highest recommendation.
Address ENGINEER, care of MARINE ENGINEERING.

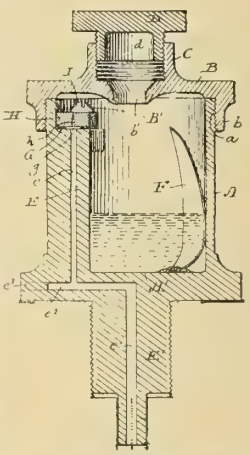
**ENGINEERING CHEMISTRY.**

Experienced analytical chemist would undertake investigations for engineers, or steamship companies.
Address CHEMIST, care MARINE ENGINEERING, World Building, New York.

WHEN CALKING
DECK SEAMS AND CHECKS IN RAILS, MASTS AND BOOMS,
**USE ELASTIC SEAM COMPOSITION.**
It is made in all colors and is positively guaranteed superior to any other seam preparation. It will not crack. When the wood expands it shrinks, and when the wood shrinks it expands. In use on steam yachts
SOVEREIGN, CORONET, ALMY, RESTLESS, VENTURE,
INTREPID, VALIANT, ELANOR, CLERMONT, BLACK PEARL,
and many other yachts and other vessels.
**A. N. COLE, Foot of 24th St., BROOKLYN, N. Y.**

*BANGS AUTOMATIC*
**ROD AND ECCENTRIC CUP**
**FOR MARINE ENGINES.**

***It is a positive fact*** that about 90 per cent. of the oil generally put on engines is wasted. Do you know that the Bangs Automatic Oil Cup will save this waste? It is something worth thinking over.



***The Bangs Cup*** is absolutely automatic; it will oil bearings thoroughly and uniformly; will will keep pins cool; reduce oil bills; it needs no special attention; will save its cost many times every month; will not feed when standing still; will lighten the labor of the oilers; will feed any kind of oil. It is exactly what we claim and what our testimonials prove it to be.

**These Cups have been adopted by the American Line and the Red Star Line for all of their steamers.**

**The James Reilly Repair and Supply Co.**

229-230 WEST STREET, NEW YORK.
FOOT OF WASHINGTON AVE., PHILADELPHIA.